SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. II., No. 29.
Scientific American, established 1845.
New Series, Vol. XXXV., No. 3.

NEW-YORK, JULY 15, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

THE COAST SURVEY EXHIBITS AT THE CENTENNIAL.

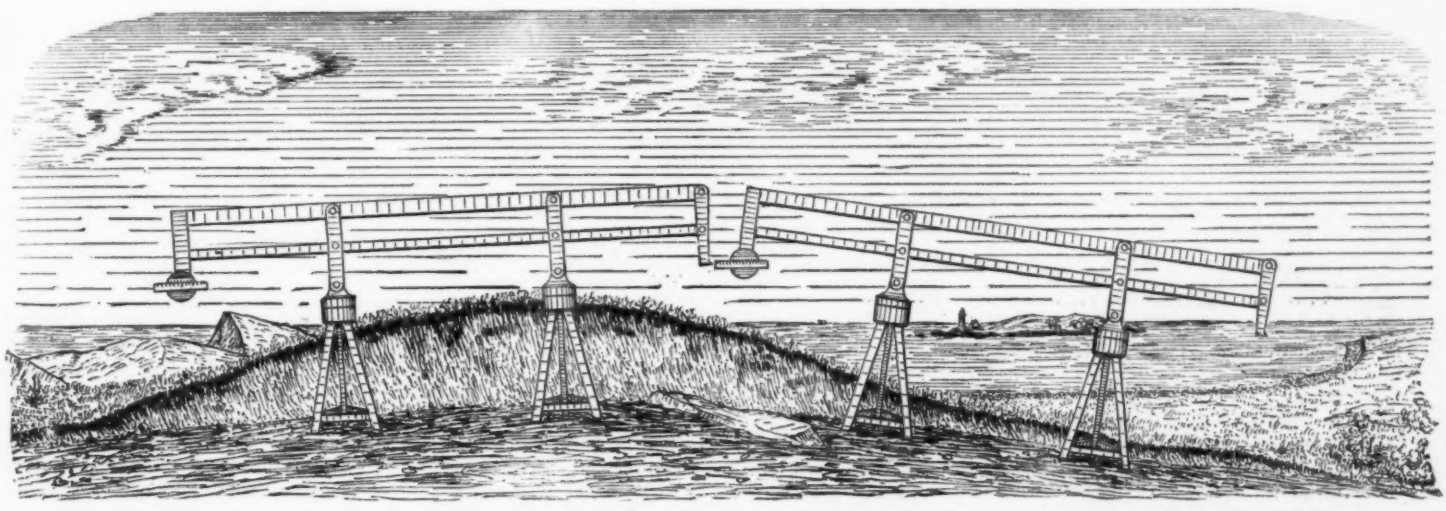
In the portion of the building allotted to the Treasury Department is an exhibit of various instruments by the Coast Survey. These instruments can hardly be over-estimated in their value to the American people.

The Coast Survey, as its name implies, is the especial friend of the mariner, making and correcting his charts to keep pace with shifting sands of the harbor-bar, and also locating by courses and distances, or by latitude and longitude, the lighthouses and signals that direct his course, and the harbors and ports to which he sails. To do this comprehensively, over coast lines extending thousands of miles, resort is had to the method called triangulation. Thus, suppose these points, as A, B, and C, in sight of each other, A being five miles from B, and due north of it; C directly east of A, and northeast of B. Now it is evident that the points A, B, and C would form a triangle, the angle at A being a right angle of ninety degrees, the angle at B being only forty-five degrees. But a right-angled triangle, in which the hypothenuse makes an angle of forty-five degrees with the base, is exactly one half of a square, divided diagonally. Now, in any square, the length of all of its sides is equal; and by this fact the distance from A to C is shown to be equal to that from A to B, or five miles, while the distance from B to C is to five miles as the diagonal is to the side of a square; or, in round numbers, seven miles. Again, suppose another point, bearing due south, and visible from C, and also exactly southeast from B, as D. In this case the triangle B C D shows a right angle at B, an angle of forty-five degrees at C, with a length on the side B C of about seven miles. Again, the angles indicate exactly the half of a square, consequently the distance from B to D is equal to the distance from B to C, or seven miles, while the side C D forms the hypothenuse, equal to ten miles; also the side C D is found to be ten miles, while the side A C was five miles; these form a right angle at C, and the length of the side A D of the triangle A C D will be found by squaring the two sides A C and C D, and taking the square root of that sum thus, the square of the side A C, which is five miles, will be twenty-five miles, and that of C D, or ten miles, will be one hundred miles; added they make one hundred and twenty-five miles; the square root of this number is eleven and a small fraction, the exact distance from A to C. Accurately measured and with little trouble, although mountains or cataracts may intervene, and the person who does the whole of the work has never been to D at all, this work may be, and in point of fact is, extended the whole length of the coast, by simply erecting triangles upon triangles; the length of all of the sides of every triangle is found, and the whole area of territory covered, accurately mapped out, the only difference between the actual work of the Coast Survey in this respect and the case given being, that the case given consists of only right-angled triangles, while the geometrician is not confined to these, but measures triangles of various forms and sizes. But with him, as in the case above, the whole work in every portion depends for its accuracy upon the correct measurement and location of the base-line A B; for if the distance A B had been erroneously stated by the surveyor at ten miles instead of five, the error would be found in every line measured therefrom in the same proportion; thus, an error of five miles in A B would cause an error of seven miles in B C, and of more than eleven miles in A D. And in practice, an error of one tenth of a mile, in a base of five, would cause an error of more than one fifth of a mile in the line A D, and in a coast-line of two thousand miles the error would amount to twenty miles.

From this will be seen the importance of extreme accuracy and certainty in the measurement of the original base-line. And, to meet this call, the engineer has for use only such materials, as wood or metal, as he finds upon this earth, all of which, without exception, are liable to perceptible change of dimensions by change of temperature, or other causes; here is the problem—to make a standard, a big yard-stick that will not alter its length from one mark of the scale to the other, neither in rain nor sunshine, winter nor summer.

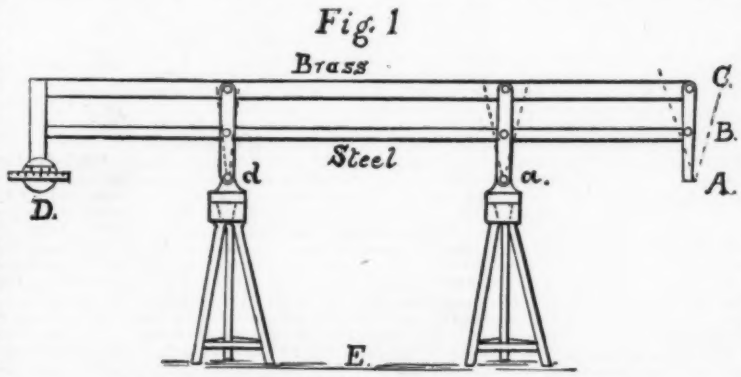
To obtain this, advantage is taken of the fact that different metals do not expand equal lengths with equal changes of temperature: thus brass and steel both expand by heating, but brass (again in round numbers) twice as much as the steel; therefore a rod of brass being laid parallel to another of steel, will, if cut of equal lengths, when both are at seventy-five degrees Fahrenheit, be longer than the steel when both are warmed to one hundred degrees, or shorter than it if both are cooled to fifty.

Now, if these rods be fastened together firmly at one end, but separated a little from each other, and a short lever A be jointed to both, as in Fig. 1, and the length A B be made in the same proportion to the length B C that the expansion of the steel bears to the expansion of the brass, then the various expansions will throw the lever into the different positions shown by the dotted lines, and in all the changes of temperature the distance A D will remain unchanged; and as in practice it is a necessity to maintain the points D and A in position, not only relative to each other, but also relative to the earth, it is supported by two similar levers *d* and *a*, so that although during the time from the cool of the morning to the heat of the afternoon the rods may expand through all of the variations of length shown by both dotted and full lines of the cut, the position of D, *d*, *a*, and A, relative to each other, and relative to the ground E, shall remain absolutely the same.



THE INTERNATIONAL EXHIBITION OF 1876.—COAST SURVEY MEASURING INSTRUMENTS.

Fig. 1



COAST SURVEY MEASURING INSTRUMENTS.

But the brass and steel not only expand differently with the same change of temperature, but also one, from a naturally greater capacity to receive heat, will get warm quicker when both are subjected to the same heating influence than the other, therefore the rod that will heat the quickest is made proportionably the largest, that they may change their temperature equally at all times; and it is in this class of work that the experiments of scientific men, whose utility is so often questioned, are found to have been absolutely necessary to perfect results.

One great difficulty in obtaining a perfectly accurate base-line arises from the fact that a perfectly straight and level track is not easy to find on this coast, except it were taken over the ice in the winter. True, this has been done, and soundings taken at distances measured upon the ice, by private parties; but in general, mittens or numb-fingers are neither of them conducive to accuracy in manipulating delicate instruments. This work has been on a straight track, graded to an approximately level bed; but as the change of the grade from level to incline, or from one incline to another, will sometimes necessitate a difference in the elevation of the instruments, which are used in pairs, one being set at the starting-point, and the other placed in contact with it and left *in situ*, while No. 1 is brought forward and placed ahead of that, when No. 2 is brought forward of that again, as one would measure a board with two rules, the alignment or direction being carefully preserved throughout. Here it will be seen that a change of inclination of the instruments (as seen in the cut) would tend to cause errors or slight variations at the point of contact.

Wherefore, the small lever A of Fig. 1 being provided with a knife edge, the other or fixed end D is provided with a short bar that can swing up and down, and provided with spirit level, slide, graduated scale, vernier, etc.; so that the operator having set the rod brought forward as near as may be to the one in place, the actual and final contact is attained by means of a level bar brought into contact with a knife edge by a fine and delicate motion, that it may not move the one already placed. This will be understood by referring to the larger cut, remembering at the same time that the illustrations are intended to show the principles involved, but do not pretend to give the actual sizes or details, such as levels, screws, and vernier glasses, and of the struments; nor the metallic case, a plain-painted, cigar-shaped tube, nearly twenty feet long, which in fact conceals all that has just been explained from the casual observer as completely as the rifle barrel conceals the powder and ball. But the gentleman in charge will, if requested, uncover the knife edge and point of level contact, and, opening a small cover in the side of the metallic case, he will show and explain the graduated scale, vernier, and other details. These instruments were designed by the late Professor A. D. Bache, and are considered the most perfect for their purpose of any in the world. And, while considering these instruments and the men who can devise, make, and use such, it appears particularly appropriate that the United States standards of the yard, bushel, and measures of weight, etc., should be placed in their charge. Accordingly in the same exhibit are seen these standards, and also fine comparators, for comparing measures and standards. Also an astronomical transit instrument, with a Bond astronomical clock or chronometer, electro-galvanic battery, chronograph or instrument for registering the time, and all the paraphernalia for taking observations of longitude by telegraph, a method claimed as purely American; and also a delicate apparatus for correcting the personal error in making such observations.

The principle of this method of taking the longitude is this:

Suppose two observers—one, say, at Washington and one at San Francisco—provided with chronometer and telegraphic communication, should observe the actual times of the transit or southing of any one fixed star, on the same night at both places; as, if the observer at Washington should note the passage of Altair over his meridian at precisely eight o'clock, and

should have registered by the telegraph and clock-work its passage over the meridian at San Francisco at exactly eleven o'clock and twenty minutes by the same chronometer, then he would say, as three hours and twenty minutes is to the whole time of one revolution of the star, so is the number of degrees of longitude between Washington and San Francisco to the whole circle of three hundred and sixty. Of course, the whole value of such work depends upon the accuracy of the observations; hence extraordinary efforts are made, not only to have clocks and instruments of most delicate and reliable construction, but also to eliminate the "personal error" of the observer. Note the word, and ponder; for the fact that the "personal error," in taking note of any thing, has not been eliminated, vitiates and destroys the value of the major portion of that which we are taught on this earth. In the case under consideration, the observer is provided with a telescope containing five parallel and equidistant wires, across which the star appears to pass. The observer, with his eye at the telescope, notes the time of crossing each wire with his telegraphic key-board, thus getting five observations at one transit. Any inequality of the times of passing from one of the equidistant wires to another argues an error in the observation, and by repeated comparison with similar observations by others, and continued practice, the observer is enabled to reduce the personal error to a minimum, and practically observations are proven correct to a very small fraction of a second.

By such astronomical observations taken at points widely distant from each other are the results of the triangulation tested and assisted.

Another branch of the Coast Survey is the "establishment of the tides." This word does not mean to locate and put in operation tides where there were none before, but only to observe and compare the times and heights of the tides at any one place, and from them to deduce an approximate table of the tide for the future. This is called the establishment of the tide at that place. The tides, it is well known, are caused by the attraction of the moon; but, although the moon keeps the tides swinging like a pendulum, other causes have great effect in causing irregularities in the time and the height of the wave. If the earth were a globe covered with water of equal depth in all parts, the action of the moon would in itself be regular and steady enough to cause a steady wave following her in her apparent motion around the globe; but the great continents lying directly in the path of this wave stop it, and while the continued revolution carries the moon around so that her influence is nearly lost on that wave it recedes, governed by the law of vibrations, coming again and receding the second time soon enough to come again the next time with, and again aided by, the moon, thus making two complete vibrations for each apparent revolution of the moon. The sun also causes a tidal wave or vibration precisely similar to that of the moon, but so very much less in quantity that it is generally only noticed by its effect upon the latter. Thus, when the sun and moon are apparently together, and when they are apparently in opposition to each other, both the solar and lunar waves, being each a double set, will agree in point of time, and, being added together, are the spring tides; also, when the moon is at the quarter their influences are alternate in time, and the solar wave being subtracted from the lunar gives the neap tide.

It will be manifest from the above that the nearer to each other the sun and moon are in their direction from the earth's centre, and the nearer that line of direction lies in the plane of the equator, the higher will the tidal wave rise; hence the spring tides of the vernal and autumnal equinoxes are higher than those of June or December.

The next disturbing cause in regard to the regularity of the tides is the conformation of the bottom and the contour of the coast. Thus, in some cases the wave, crowding into a funnel-shaped contour, rises unnaturally high, and in other cases the same wave, throttled by a narrow passage, fails to affect large bodies of water beyond. The wind, also, especially in bays and harbors, has its effect upon the tide, increasing or decreasing the extreme height of the wave, and also accelerating or retarding the flow of the wave; and so perceptible are these effects that it is impossible on any one day to predict the time of the highest water for the next day within a few minutes, except as a probability, not certainty; nor can the extreme height that the wave will attain be predicted within a few inches, except under the same condition.

For these reasons, all sailing directions in scientific works speak of "mean" high or low water, all soundings on the charts being reduced to that standard; and the captain, when crossing the harbor bar, ascertains the state of the tide—whether high or low, spring or neap—and mentally reduces every cast of his sounding lead to the "mean" standard of his chart. This "mean" is deduced from a long series of observations, made and compared with great care and labor. And to reduce the amount of this labor, as well as to decrease the liability to error in taking the observation, there has been devised the Self-Registering Tide Gauge shown in the Exhibition. It consists of a float, that rises and falls with the tide; a clock that turns a cylinder carrying a sheet of paper, the paper being ruled longitudinally for feet and inches, and across at regular intervals, agreeing with hours and minutes, as wound off by the clock. A marker arranged to traverse the length of the cylinder is connected to the float, and as the paper is wound off by the clock the marker carried across it by the float traces a sinuous line, telling at a glance the actual height of the water at any time during the observation. In this way a continuous record of the tides is obtained, and from that the establishment of the tides for the place of observation.

A. V.

THE INTERNATIONAL EXHIBITION OF 1876.

No. 16.

FOREIGN CAR-WHEELS.

THE car-wheels in the foreign departments of the Exhibition will strike American railroad men as being very foreign indeed. With the exception of a few cast-iron wheels in the Swedish and Canadian departments, all that have been sent from abroad are made of either wrought iron or steel, with steel tires.

The Toronto Car-Wheel Company has sent two pairs of 33 in. cast-iron wheels of the Washburn pattern pressed on the axles; one pair of 28 in. wheels, which are labelled "Elmslie" pattern, the pair being of the metre gauge. This pattern of wheel has a corrugated plate, the corrugations being circular or circumferential, with curved ribs on the back and extending from the hub to the rim, with short ribs or brackets between and extending a short distance only from the rim and the hub. The weight of the wheels, 340 lbs., is marked on them—a practice which could be followed by other makers to great advantage. The journal of the narrow-gauge axle is 7½ in. long x 3 in. diameter, a fact which the members of the Master Car-Builders' Association who are disposed to reduce the size of the standard axle would do well to notice.

The Toronto Company also shows a specimen of a spoke-wheel for engine trucks, and a 24 in. plate wheel, the corrugations of which extend radially, or from the hub to the rim. It has also specimens of broken wheels, showing the chill. The wheels have all been sent in their rough condition, as they came from the foundry, with the exception of one pair of the larger wheels, which are painted brown. The exhibit is, however, in very bad condition to be seen, a part of it being covered with rubbish, due to the fact, doubtless, that the Canadian department is still in an incomplete condition.

There are also some specimens of cast-iron wheels in the Swedish departments in both the Machinery Hall and in the Main Building. In the former are some wheels of the same pattern as those marked "Elmslie" in the Canadian department. They are marked "Arbogn," and so far as was possible to interpret the Swedish language they are exhibited by "Arbogn," but whether the name designates an individual, a place, or a company there was no intelligible means of determining. There are two full-sized wheels for ordinary roads, one of 30 and the other 32 in. diameter; narrow-gauge wheels, 19, 21, and 26 in. diameter, and a pair of plate horse-car wheels on an axle. They were all of the "Elmslie" pattern, excepting the latter, and had wrought-iron rings shrunk on the hubs on the inside of the wheel. These rings were carefully turned off—a work of supererogation, if the wheels are used on axles with outside bearings.

In the Swedish department in the Main Building are some specimens of wrought-iron wheels which have been in service, and which have been sent to show the performance of Bessemer steel tires made by the Sandvik Works. Some of these wheels have cast and others wrought-iron hubs. Wheels of this description are in use very generally in Europe, and specimens are exhibited in the Swedish, French, Belgian, and German departments. Those in the Swedish department referred to were taken from the "Geffe-Dahla Railway without being turned. This railway has ascents of one foot in 60 and curves of 1000 feet radius." One pair of the wheels is reported to have run 127,321 miles, and the others 147,742, 187,759, and 260,615 each. They are 38 in. in diameter, and all still in tolerably good condition.

In Machinery Hall, just adjoining the "Arboga" exhibit, is a number of wrought-iron wheels from the Surakammar Works. There are two wheel-centres, one of which is turned out at the hub in a concave form, so as to show the welding of the spokes in the hub. In the specimen it is of course perfect. The question which arises is, not whether this can be done in the *majority* of cases, but whether there can be any certainty about doing this in *all* cases. There are also with this exhibit one pair of wheels with wrought-iron tires which have run 125,000 miles, and another pair which are entirely new. It is to be remarked that these wheels are keyed to the axle with ordinary square keys—a practice which has gone entirely out of use in this country. The journals of the axles are 7 x 3½.

In the French department in the Machinery Hall, Messrs. Brunon Brothers, of Rive-de-Gier, exhibit specimens of car-wheels, iron buffers, and buffer-boxes, which are marked "hydraulic press forgings." The "shapes" used in forging the wheel, and which form the spokes and rim, are placed together, so as to form a complete wheel. When heated to a welding heat, they are exposed to hydraulic pressure under dies, and are welded together by a single process. A number of these wheels are exhibited, and also iron buffers, buffer plates, etc., the latter of forms not used here.

Adjoing the exhibit of Messrs. Brunon Brothers is that of Mr. Lucien Arbel, proprietor of the Forge of Couzon, Rive-de-Gier, Loire, France. This consists of a collection of wheels for both engines and cars made by a process of hydraulic forging. These wheels are all made with straight spokes, of an elliptical section, similar to those ordinarily used for cast-iron driving-wheels, excepting that those of wrought-iron are much lighter. The largest wheel-centre is 7 ft. 3 in. in diameter, so that the wheel with its tire would be 7 ft. 8 in. The spokes of this wheel are 3⅞ in. wide and 1⅛ thick. There are, however, more spokes in the wheel than would be used in one made of cast-iron.

The process of manufacture is shown by a photograph taken in the works, from which it was inferred that the rim, with suitable notches on the inside to receive the spokes, is made first. The spokes are then laid in their proper position in relation to the rim, but considerably "dished," and the spokes are then secured to the tire by clamps. A suitable pile is built up in the centre to form the hub, and others for the crank-pin hub and counterbalance. The whole is then heated to a welding heat, and subjected to a powerful pressure in suitable dies, which complete the wheel in a single process. By dishing the spokes, they are forced outward when subjected to pressure, and thus a good weld is secured to the rim. Mr. Arbel has given some valuable and interesting facts regarding his manufactures in a letter, which will be published hereafter. The sizes of the wheels exhibited vary from that given above down to wheels for hand-trucks and brake-wheels.

In the Belgian department, the Société Anonyme des Ateliers de la Dyle, of Louvain, exhibit a variety of wrought-iron wheel-centres, some with cast and others with wrought iron hubs. The patterns shown are those used on Russian, Belgian, German, Roumanian, and Chilian railroads. Many of them are of forms similar to those illustrated in Figs. 1 and 2; others are slightly different. In some cases the two bars which form a spoke are brought together, and either secured by a rivet, or else welded together. There are also specimens of wheels with spokes made of a single flat bar, and one pair of wheels and tires on an axle. The journals of the latter are 3½ x 6¾ in., showing that the standard axle adopted in this country is very nearly that which foreign engineers are using, though there are but two such axles under a European freight-car which carries 22,000 lbs.

In the English department in Machinery Hall are several pairs of Mansell wheels, 40 in. in diameter. These have wooden centres, with steel tires. The wood is made in sections with the grain running radially to the centre of the axle. There are also specimens of wrought wheels similar to those illustrated. The space or department in which these wheels are exhibited is still in an incomplete condition, so that no particulars in relation to them were procurable.

In the German department, Krupp, the great steel manufacturer, exhibits steel locomotive and car wheels, but this, too, is still incomplete, and there seems to be good reason for doubt whether it will be in thorough order before the culminating date of the Exhibition, which will of course be on the Fourth of July.

One feature to be remarked about the foreign exhibits of wheels, as well as nearly all other machinery and what may be called mechanical material, is the entire absence of chromo engineering. There is, we believe, in the entire foreign exhibits which have been described not a stroke of a brush which is intended for ornament—that is, on the objects exhibited. In most cases the wheels have been sent without any paint at all, the exhibitors having learned that meretricious ornamentation detracts from instead of adding to the effectiveness of the objects exhibited.

In many cases there is a marked deficiency in the exhibits, not only of wheels, but of other objects, in not providing means of giving information to visitors, either by an attendant or descriptive circular, or both. Without these the benefit which the Exhibition would or might have is to a great extent lost, because the impression produced on visitors is not a permanent one, owing to the vast multiplicity of objects presented to his attention. A clear, descriptive circular would be carried away, and if the person is interested in the objects exhibited, it will be preserved and referred to afterwards. The sole object of exhibitors ought not to be to attract attention, but to communicate information. If this is done in the clearest and most concise way, it will be effective in proportion to its clearness and conciseness.—*Railroad Gazette.*

NOTES FROM THE EXHIBITION.

NOVEL TYPE MAKING AND SETTING MACHINE.

THERE have been more than one machine made for the purpose of setting type, and some have seemed to work very fairly, but it was left for this Exhibition to bring forward a machine combining both the making and setting; a machine that distributes by simply tossing the type, after the printing is done, into the melting-pot, reproducing them at the will of the operator. Of the economy of the plan it is for printers to judge; of its mechanical feasibility, there is no room for doubt.

The machine is shown in full operation and the visitor can have his "matter" set up in type hot from the matrix. The machine itself is not so large as a common piano, and has a set of keys, each of which is marked with a letter, or space, or numeral, etc.; these are conveniently placed at one side, near the end. At the opposite corner is the melting-pot, kept at the proper heat by a gas-furnace; under the machine, running lengthwise thereof, is a shaft carrying a large cylinder, that is, in fact, a large cam, having on its surface various flanges of proper outline, that in passing operate the levers and perform the work; this is driven by a belt continuously.

The matrices are arranged to slide upon touching the keys, coming forward into the track of another carrier that, sliding across their line of motion, takes the matrix from the key, carrying it to the melting-pot; when the type is cast and delivered to the rubber, the matrix returns to its place, and, touching another key, another matrix starts forward; the type, after leaving the matrix, is rubbed to finish its surfaces, and delivered on the composing-stick, at the left-hand of the operator, all in line, ready to be made up and put in form. This machine (Westcott patent), exhibited by the American Type-Machine Company, of New-York, goes just as far as type-setting machinery has ever been successful, and stops just where all such machines appear to be fated to remain. What it undertakes it performs. With the help of a brain to spell the matter, it will throw the type into line with perhaps less finger labor than the hand-workman; but this is work that is by no means the test of a printer: boys and girls can be taught to throw type into line on a composing-stick, but every printed work—this page of this paper, for example—is composed of columns, or pages, containing lines of unvarying length, while in no two lines will words of the same number, with letters requiring the same space, occur. If in throwing the type into a single line, the precise points where the line would end when cut up for the column should always occur at the joint between two types, it would be easier; but this is not likely to occur often if at all, the more common rule being that the last type will crowd, or refuse to come into place. In this case it is necessary to sometimes take out from the middle of the line a "quad," or blank, and substitute a smaller one, letting the type in at the end, or a larger one, crowding it out altogether. And it is just here that as yet all type-setting machines fail to come up to the mark, and the brain and judgment of a good workman are the cheapest means to attain the end yet found. A similar case arises in making up the columns that form a page: these must be brought to the exact length, and it is often a matter of judgment for the workman whether to reduce some "display line" to a smaller type, or "lead" a line somewhere and drive the last line clear over into the next column; and in the making up of the large daily papers very little time can be taken to consider, yet the general appearance of the sheet must be fair. A country editor once closed a column near the middle of a page with the words, "We want just three lines to complete this column; just three lines. Well, here we have them"—not very interesting matter to the public, perhaps, but looking better in the page than to have commenced the "leader" of the next column at the foot of that one. Similar cases, although, perhaps, not so candidly confessed, occur even at the present day.

NEW ENGRAVING MACHINE.

Similar to the above-described machine, in the interest and curiosity it excites, is the Pantograph Engraving Machine, exhibited by the Hope Company, of Providence. Like the other, it is a great saving of hand labor, and appears to perform all that its builders intended; also, like the other, it is by no means the first of its class, but rather the representative of the latest improvements. It is well known that, at the present day, calicoes and print goods are produced by passing them over rollers of copper or steel, that have the desired patterns cut in, or engraved upon their surface; into this engraved pattern the dye is put, to be transferred to the cloth in passing; and the purpose of this machine is to engrave these rolls. The machine itself consists of a frame, some five or six feet long by about four wide, and near four feet high. On this frame is seen the roll, about five inches in diameter, and as long as the cloth it is to print is wide. Back of this, in bearings that permit it to both slide and turn, is a shaft carrying five arms or levers, each provided with a diamond-point, or burin, at the end, and so adjusted that they can all be thrown down upon the copper roll, at once, by the rocking motion of the shaft, and drawn along on its surface by the sliding motion thereof. At the same time the roller can be turned upon its axis, thus producing five cuts of any desired form, and all geometrically similar at each stroke.

The operator, sitting in front of the machine, has the design to be produced properly drawn on paper, and secured upon a small table, above which hangs a pointer at the end of an arm similar to those carrying the burins. By means of levers and connection (readily comprehended by the mechani-

cal mind), the pressure of the pointer upon, and its passage over the pattern, throws the burins down upon the roller, and traces on it five copies of the pattern followed. A treadle, conveniently arranged, brings the power of the foot in as an auxiliary, to relieve the hand of the heaviest part of the labor, enabling the hand to exercise the delicacy of touch and motion required to reproduce the finest patterns. The number of the patterns produced upon one roller may be increased or decreased at the option of the designer, who, knowing the length and circumference of the roll to be used, is supposed to account for the whole of the surface, that when printing the goods the roll will reproduce the pattern, whether continuous as a vine, or broken as spots, in regular order. And an examination of any piece of calico, however intricate in design, will show by any particular mark, reproduced in the same color, in regular succession, the size of the roller by which it is printed; and as one roller is only expected to print one color, so the number of colors in the design shows pretty surely the number of rollers that were engraved for it. The machine mentioned would appear to be a very economical one for large establishments in the saving of skilled labor effected by it.

How this method compares with the common one of engraving a single copy of a pattern upon a steel roller, then hardening the steel, and reproducing the pattern by pressure, first upon another soft-steel roll, where the pattern appears the reverse of the other, and with the depressed parts raised, or in relief, and which in turn being hardened, the pattern is, in like manner, transferred to the copper as many times as is desired, is a question that can only be decided by experience. In either case, the pattern as seen upon the copper roll is the reverse of what appears upon the calico, which shows the design right or left, to agree with the second or raised-steel roll of the last-described process. A. V.

THE HOT BLAST.

AT the session of the American Institute of Mining Engineers, held June 21st, in the Judges' Pavilion, Centennial grounds, for the reading of papers and discussions, Mr. A. L. Holly, the President, occupied the chair.

Mr. J. Lowthian Bell, M.P., of England, read a paper on "The Hot Blast, and an explanation of its mode of operation in iron furnaces of different capacities." He said there has been probably no improvement in the manufacture of iron which created more surprise in the minds of practical smelters and of scientific men than Neilson's discovery of the hot blast. In 1829 Messrs. Dunlap & Co. consumed at the Clyde Works, near Glasgow, nearly 7¼ tons of coal to make a ton of pig iron, of which about 20 cwt. was employed under the boilers of the blowing engines, leaving nearly seven tons for the consumption of the furnace itself.

In 1833, by heating the air to 612° Fahrenheit they reduced the 7¼ tons to three tons by burning hundredweights of coal in the apparatus for raising the blast to this temperature. Anterior to Neilson's time the fuel employed in smelting iron was coke, and it was supposed at that period, erroneously, however, that coal in the raw state, when burned with cold air, was totally unfit for the purpose in question. Making a proper allowance for collateral circumstances, we are within the mark when we admit that in actual coke, which is really the form the fuel was to assume before being burned in the blast-furnace, not less than 30 hundredweights were saved by heating the blast to 615° Fahrenheit. Numerous have been the opinions advanced by different authorities in the scientific world to account for the apparent anomaly, but none, in my judgment, satisfactorily explains the mode of action of the hot blast.

The object of this communication, therefore, is to present for our examination certain views which I have been led to adopt on this subject after bestowing upon it some considerable attention.

Mr. Bell then briefly reviewed the nature of the process which is carried on in our iron furnaces, whether it be fed with hot or with cold air. In opposition to opinions formerly expressed by others, Mr. Bell ascertained during an extensive series of experiments that oride of iron was susceptible of reduction to the metallic state at temperatures far below that believed to be necessary. This was proved in a variety of ways. In a very few minutes after the ore has been shot into the throat reduction begins, and, in most cases, by the time it has travelled downward through 12 or 15 ft. this division of the process may be said to be completed. Below this level, omitting airy chemical action connected with the formation of cyanogen salts, the value of height in a blast furnace must only be regarded as a means of interrupting the heat which is carried upward by the rapid current of gases generated by the combustion of the fuel at the tuyeres. These gases immediately expanded by the high temperature prevailing in the hearth, arrive speedily at the point of exit, and in the event of the furnace being of insufficient height they carry with them, in the form of sensible heat, the useful effect of a considerable portion of the combustibles employed in the operation.

By means of suitable openings in the sides of two furnaces —one of 48 and one of 80 ft. in height—Mr. Bell learned that in the lesser by the time the materials had reached the depth of twelve feet from the top they had attained a full red heat, whereas in the larger its contents did not acquire this temperature until they had descended to a distance of about twenty-four feet from the charging plates. Repeated analyses of the gases as they left the furnace satisfied him that nearly the full equivalent of carbonic acid, due to reduction and to carbonic oxide dissociation, was to be found in those of the loftier furnace, whereas something like one fifth of this higher oxide of carbon had disappeared in the other. Until a dozen years ago the furnaces in general use rarely exceeded fifty feet in height.

About the period just spoken of a bolder experiment was tried at Middlesborough by a firm who raised one of their furnaces from 45 to 75 feet. The change was eminently satisfactory, being a saving of fuel equal to that saved by the use of hot air. Had the use of furnaces 70 or 80 ft. high preceded Neilson's invention, Mr. Bell did not think it would have occurred to ironmasters to have attributed the saving of coke to any mysterious peculiarity in the nature of the combustion which takes place at the tuyeres. Instead of propounding puzzling doctrines, as has been done, to account for the heat proceeding from a few hundredweights of coal burnt in the hot-air apparatus, saving a much larger weight in the furnace, they would probably have sought to identify the mode of action of the hot blast furnace with that of a mere addition of capacity. He then showed how the substitution of heated for cold air was equivalent to an increase in the capacity of a furnace, and then followed this up by pointing out the circumstances which, in his judgment, performed a supplementary part in raising the efficiency of a furnace using hot blast.

The circumstance of the upper region being a heat-evolving one was of importance in his opinion, because to it was due the fact that if certain dimensions of furnaces were reached no further cooling of the escaping gases ensued. The advantage resulting from the use of a sufficiently lofty furnace is the adjustment of the temperature of its different zones, so that the ore is reduced under circumstances where, so far as possible, this unturning, as it were, of carbonic acid is avoided. The same end is attained by diminishing the volume of gases attending the generation of a given amount of heat. This happens when the blast itself is raised in temperature, while the saving of furnace fuel is necessarily increased by the heat of which the air is thus made the vehicle.

It has been stated by the advocates of intensely heated air that we were justified in assigning to every addition of 100° to the blast the same saving as that effected by any other 100° which preceded it. This is manifestly an error, because, with each step in the diminution of the fuel consumed, there is a corresponding diminution in the quantity of air required—18 cwt. is still confidently predicted as being the future consumption of fuel in the north of England by one or two gentlemen. In confirmation of this doctrine, limited periods of working have been given, showing what are regarded as an exceptionally favorable state of things, but it is unnecessary to dwell on the satisfactory character of the results of a single week. Mr. Bell then dwelt on the expediency of heating air beyond a certain point, as applied to furnaces where the dimensions are sufficiently large to afford the reducing gas ample time to expend its energy on the work it has to perform

Dimension of furnace and temperature of blast, he maintained, were convertible terms until a certain composition of the gases was arrived at. The views he had expressed were founded on experimental labors and investigations, having for their object t e solution of a purely practical question. Mr. Bell concluded by saying that it became necessary for his own guidance in the future to learn whether any further addition to the capacity of the furnace or to the temperature of the blast would present any advantage in the economy of fuel. With the Cleveland iron stone the furnace has reached at the very outside 15,000 cubic feet, and has its blast heated to 905° Fahrenheit. Then he said: "I answer in the negative. If the opinions thus expressed embrace any fallacy, they at least possess the recommendation of constituting those upon which I have recommended those associated with me to act."

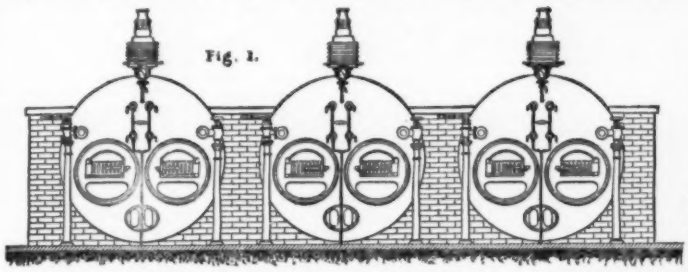


Fig. 1.

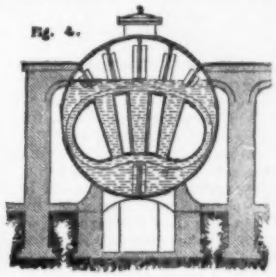


Fig. 4.

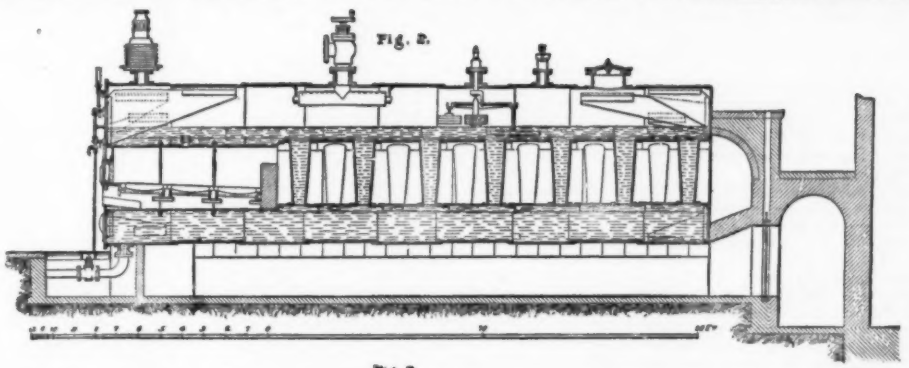


Fig. 2.

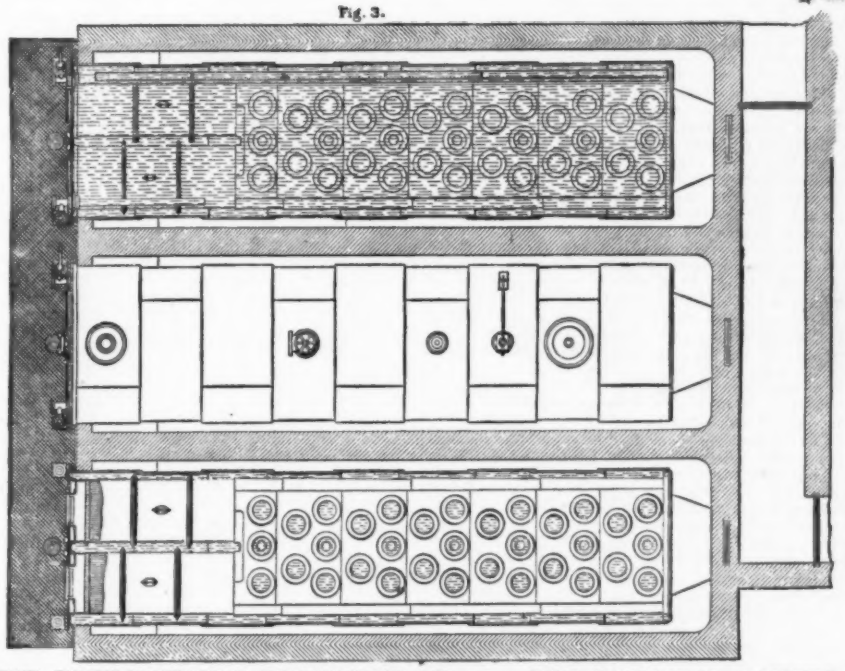


Fig. 3.

THE INTERNATIONAL EXHIBITION OF 1876.—THE GALLOWAY BOILERS.

GALLOWAY BOILERS.

WE illustrate the three boilers sent out from England to Philadelphia by Messrs. Galloway & Sons, at special request, to the Boiler Department of the Exhibition. They are of the type well-known as the "Galloway" boiler, and include some improvements in construction which have recently been introduced by their makers. Each of these boilers is 28 ft. long by 7 ft. in diameter, and is suitable for an ordinary working pressure of 80 lbs. to 90 lbs. to the square inch; the shell being made of best annealed steel plates ⅞ in. thick. It will be seen that in the cylindrical shell is placed an internal flue, consisting of two furnaces at the front end uniting into one back flue of an irregular oval form, this back flue containing thirty-three Galloway tubes. Baffle plates or swinging doors are also placed at the sides of this flue, to drive the heated gases against the tubes instead of allowing them to escape along the sides to the chimney.

This back flue constitutes the chief feature in the Galloway boiler, and those who are acquainted with it will notice that an important improvement is introduced in the boilers exhibited—namely, making the flue concave at the bottom instead of convex as heretofore. This gives considerably more space underneath the flue and enables the attendant to thoroughly cleanse the boiler and examine it in its lower part. This arrangement could not have been carried out satisfactorily so long as the tubes were placed vertically, as too great a space would have been left between the tubes at their lower ends to make that part of the flue sufficiently strong, unless very thick plates (which are always objectionable) were used in the construction; but by placing the tubes in a direction converging towards the same centre, as shown, from which both the bottom and top of the flue are struck out, as shown in Fig. 4, the necessary strength is obtained whilst using the ordinary thickness of plates, as the tubes are nearer together at the bottom than at the top. This form of flue enables all the Galloway tubes to be made of precisely similar size and shape in the flanges, so that all the tubes in the boiler are interchangeable; this is an important consideration in the construction of any mechanical appliance nowadays. Each of these boilers is capable of supplying sufficient steam to drive an economical condensing engine indicating 300 horse power.

Messrs. Galloway have been making this form of boiler now for nearly 25 years, and with their present capabilities can turn out at least ten boilers per week; they have recently erected new and extensive works solely for the manufacture of this special form of boiler, special tools being put down at both their establishments, so as to insure better workmanship and greater uniformity in its construction.

Along with the boilers three of the cone tubes are exhibited; some thousands of these are now supplied annually by Messrs. Galloway, for insertion into ordinary Lancashire or Cornish boilers, as they greatly strengthen the flue and promote the circulation of water, thus preventing unequal expansion and contraction.—*Engineering.*

CENTENNIAL SUGGESTIONS—THE MODERN RAILWAY SYSTEM.

ASSUMING that in going to the great Exhibition you will take passage on the Pennsylvania road, I propose to sit beside you and indulge in a little chat. The remarkable energies that have combined to provide this wonderful display for the world are among the noblest exhibits, and I may add there are many things not labelled and in position within the buildings, that, by reason of the relation they bear to the Exhibition, may fairly be considered a part of it. Conspicuous among these is the railway, over which we are running so smoothly and swiftly, and better still, so safely. Did you ever think what rare abilities are requisite to transport you on these conditions from New-York to Fairmount Park? Not to go into any estimate of the skill necessary to make and maintain the roadway, bridges, and track in perfect condition, and to keep the rolling-stock, axles, and wheels under so careful watch that no part shall wear or deteriorate to the point of danger (carrying system to such a degree that each wheel is allotted a given number of miles to run, and is then re-cast to prevent crystallization), it may interest you to get some impression of the labor and executive talent required to arrange and manage the mere running of the trains.

The first thing, of course, is to make up a time-table, but I venture to say, in glancing at one of the printed slips so called, you have not imagined what nice calculations of time and distance enter into its composition. Of course these are complicated in proportion to the shortness of the road and the number of trains passing over it at varying rates of speed. Where many freight and accommodation lines are running, they must each move on to a siding to let the swifter mail and express trains pass, and yet in so doing suffer no needless delays themselves. The trains must all be regulated also to suit not only the convenience of local demands, but the necessities of distant connections as well.

This adjustment, too, must be arbitrary enough to secure safety, and yet possess sufficient flexibility to meet contingencies. How is this nice calculation made? Long experience and skill have devised a method at once accurate and simple too, when the difficulties are considered. I will try to illustrate it.

Take a large sheet of paper, say a yard square, and write at the top "New-York and Philadelphia—Trains going South."

Rule horizontally 180 lines across it, to represent that number of half miles between the two points and number these from one upwards.

Then rule perpendicularly 288 lines to represent the number of five-minute intervals that occur in a day of 24 hours. Mark the first left-hand line at top and bottom 12 o'clock (midnight); the twelfth 1 o'clock A.M.; the twenty-fourth, 2 o'clock A.M.; and so on till the last line at the right represents midnight again. The horizontal rulings stand for distance, the perpendicular ones for time, and the chart before you contains no less than 51,840 squares, each of which represents the equivalent of a half mile in one direction and five minutes in another. Now you are ready to put the trains upon it, and you begin with one supposed to leave Jersey City at 3 o'clock in the morning and reach Philadelphia at 8 o'clock. You lay a ruler against the former figure at top of sheet, to the latter one at the bottom, and draw a line across. That of course will indicate the passage of the train, and will show at a glance at just what hour and minute it traverses each half mile of the entire journey. Then you represent a fast mail by a line drawn from 4 15 o'clock to 7 o'clock A.M. Of course these two diagonal lines intersect, as the swifter overhauls the slower train, and a third line representing a freight will cross both of these again at two different points; so your slower trains must be on side-tracks at these points, or you already have two or three collisions on your hands—and those are the very things you do not want.

On inquiry it is ascertained that there are no sidings just there, and you begin to wonder how this particular difficulty is to be met when 172 trains are to be provided for, of which you have as yet only attempted three. While you are still in perplexity over this phase of the subject, and affected by visions of wrecked cars and wounded brakemen, it suddenly occurs to you that in ruling your lines no provision has been made for stops; and this introduces a fresh complication, which must be provided for. And here let me suggest that the places for the switching off of the slower trains must be determined somewhat by the water-stations, so that the unavoidable delay may be utilized by supplying the tender. As the motive power of the iron horse is his own perspiration, he is a thirsty creature, and must have frequent and liberal drinks. A locomotive tank contains over 100 barrels, and requires replenishing about every hour. Certain very fast trains on this road scoop up their water without stopping, from an iron trough between the rails; but this is an aristocratic libation, not allowed to the ordinary engines. It is such perfection of arrangement that enables this company to run a train from Pittsburg to New-York, 444 miles, without a single stop, and in less than 10 hours!

But to return to the time-table; before you go further with it, let me frankly tell you that there is a fact connected with it which has been entirely overlooked, and which contributes to more complication than any thing in the calculation. The lines drawn continuously straight on your chart indicate, of course, a uniform rate of speed for a given train for each mile; but this is utterly impracticable owing, to differences in weight of trains, variation of grades, frequency of stops, and other causes; so you will have to abandon the straight rulings, and substitute a series of zigzag lines to represent the constantly changing movements of the various trains. I guess, if you consider carefully what problems are to be solved, what difficulties reconciled, in providing for the running of 300 trains a day over this 90 miles, you will join me in rejoicing that Mr. Barker has charge of all these matters, and manages them so efficiently, that we have only to pay our fare and be humanly certain of a prompt and pleasant passage over his line. And if our talk has increased our appreciation of the clear-headed ability required to make a competent railway superintendent, it is a tribute not often enough paid by travellers. How do you suppose this gentleman felt, one day last week, when having completed one of the complex tables and put it in print at 10 o'clock in the morning, he received imperative orders to revise the whole calculation to accommodate certain connections of importance? What do you suppose he did? Went immediately to work to compile the new schedule, and have it ready for the regulation of the next day's trains, despatching at midnight an agent by special engine to communicate with every signal-man on the entire line, and obtain from each a telegraphed message that no train should pass his station until he had received positive orders concerning it from headquarters. Do you see the full force of this last arrangement? Had he simply sent an order it might have been misunderstood, especially at that sleepy time of day, but this plan prevented the possibility of any misapprehension, and gave the chief written evidence that the instructions were both received and understood by every subordinate. It put each man on record, and made him personally responsible. Then as the first trains started out they carried and distributed the new tables, and station agents and signal-men knew precisely what to do.

But, after all, the most wonderful thing about it is the system by which, after the time-table is completed on paper, it is put into successful operation on the road. The one is theoretic, the other practical, and an error in the one, which can be corrected by a simple erasure, might in the other involve the loss of property and lives.

If I made the first matter clear, let me attempt an explanation of this. The whole road is divided into two parts, called "blocks," and these are subdivided into many sections, each having its telegraphic and flag-station, each being a little realm by itself, with certain general regulations of its own, yet subordinate to and under the control of the former, which are managed by "train-runners" as they are called. These "runners" sit in a quiet little office, directly adjoining that of the superintendent at Jersey City, having before them models of that "block" or portion of road which each controls, with its stations, sidings, and switches. When a train leaves Jersey City, the "runner" watching that block puts a peg into that subdivision of the model representing that section. In two or three minutes a dispatch comes to the instrument at his side announcing that it has passed East End, and the peg is advanced beyond that station. A moment later a click tells him it has passed the junction, and he makes a second move accordingly. So before it crosses the Passaic river at Newark he has received six messages regarding this one train. This same process applies to every train, and it will be seen that this plan puts before his eye a complete representation of the road and the relative position of all the trains traversing it. As fast as despatches come, he compares the time reported with the schedule before him, and records them on sheets which are kept and filed. If a train is behind its proper time, he telegraphs the station back of it to hang out a green flag, which will slow the train following it, or if needful a red flag to stop it entirely, until a safe distance intervenes. You can suppose a case in which this control of the whole road by one mind located at headquarters is most important. For example, a train has safely passed a station on time, and is so reported; but before reaching the next breaks down or has to stop for repairs. The last signal-man knows nothing of this, and would let the next train follow, but suddenly gets an order from Jersey City to stop it till otherwise ordered. Not having heard at the right moment from the delayed train, the runner wisely presumes that something has happened, and acts accordingly. And he is so located that he is under the constant direction of the superintendent himself. It is the rule of the company to assume danger exists everywhere until safety is assured. If the train is reported as in motion again, every thing proceeds as before; or if seriously delayed, he may order aid sent to it, and the other trains switched around it until it resumes its place again. He can do a hundred things with a full knowledge of the whole situation which no man with partial information would dare attempt. So while constant communication is maintained between the stations, and they have certain rules of their own, it is well that they should all be governed by a superior officer at the terminus, who directs all movements, yet sees none of them, except in miniature.

On Decoration Day, when many extras were run, the trains numbered 344 on the New-York division, and their movements involved the sending of 8600 electric messages, without reckoning those interchanged between lesser stations. As evidence of the perfect organization of this company, it may be mentioned that on the day alluded to, as 58 trains were added to the usual list, it was necessary to promote that number of assistants to act as conductors for the day, a like number of freight conductors to fill the places of the assistants, the same number again from the flagmen to supply those vacancies, and so on through several grades. To arrange all these changes without confusion or accident, and have each man in his accustomed place again the next day, shows how carefully all are trained to their duties. It is the aim of the management to use their system like a great school, wherein the employees are thoroughly educated and advanced according to ability and fidelity. The result is an efficient force of men, very many of whom have been connected with the road for years, and who can be relied on in any emergency.

Here we are at Germantown Junction, our chat having seemingly shortened the distance. The operator in the little window yonder has touched his instrument, and already the train-runner at Jersey City knows we are here in safety, and the next station north is flinging out a white flag. You are going to the Centennial depot, and I hope will notice what a splendid illustration it is of the enterprise of a company, that makes such provision for the comfort and convenience of its patrons for six brief months. Stately as it is, it was built in sixty days. I am going to the West Philadelphia station, a structure in some respects more remarkable still, with its ample train-sheds 800 feet long, and its immense waiting-rooms on Walnut street. This was built in forty-five days. I think, in saying good-bye, we must admit that such railway management is entitled to rank among the sciences, and that such examples of skill and ability are noble illustrations of American civilization in this Centennial year, and worthy to compete with the exhibits inside the gates you are about entering.

G. S. D.

INTERNATIONAL EXHIBITION OF 1876.

No. 17.

NEW BEVEL-GEAR CUTTER.

IN the German section, Machinery Hall, may be found the very ingenious little machine illustrated herewith, for which the inventor, Mr. Ed. Grube, is entitled to much credit. Although he has not accomplished entirely that which he claims to have been his object—namely, to construct a machine which should be capable of cutting a bevel gear-wheel mathematically correct—he has made an approach to it such as to promise that he will always be found in the van among inventors and mechanicians.

Upon a hollow pedestal is formed a short shears or slide, upon which the whole of the mechanism giving motion to the cutter slides to approach to or recede from the vertical mandril carrying the blank gear. A bracket on the left of the slide carries this spindle, as shown, which has upon its lower end the usual worm wheel and worm, with dividing index on the shaft of the latter. The hand wheel at the right, by means of a screw to which it gives motion, serves to move the whole of the upper work upon the horizontal slide. Upon a horizontal shaft, partly shown at the right, and running athwart the slide, are a pair of pulleys, through which motion is imparted to the cutter-shaft by the intervention of chains and chain-wheels, none of which are seen in the engraving. On the near end of this shaft is a bevel pinion gearing to a bevel-wheel shown near the hand-wheel on the right. This bevel is secured to a short shaft, on the other end of which is a disk-crank, giving motion to a short connecting-rod.

The inclined frame, besides carrying the cutter-spindle—the cutter in which is shown just above the blank in process of being cut—carries also a guide-rod, upon which the bracket carrying the cutter-spindle slides, and above it a screw which feeds the cutter up or down the incline. The whole casting carrying this guide and screw vibrates sidewise—that is, to and from the reader, or transversely to the line of the tooth—upon a pivot situated vertically over the centre of the blank spindle, the vibration being given to it by the short connecting-rod before mentioned. The whole inclined frame is adjustable upon trunnions, the slotted head of one of which is seen just above the short connecting-rod, and is secured in place by the tall screw and hand-wheel on the right at any angle desired. The cutter is the ordinary circular milling kind. By a ratchet, not seen, a pawl attached to the further end of the short connecting-rod rotates the inclined screw, and thus automatically feeds the cutter up or down the incline on the bevel to be cut.

The novel feature in this machine consists in giving to the cutter, by means of the mechanism just described, a motion transverse to its line of progress through the tooth-groove, which becomes less as it follows the converging lines of the space to be cut, from the fact that the centre of vibration corresponds with the vanishing point of the lines of the teeth. In this way, so far as any lateral dimensions of the space is concerned, the cutter, in alternately cutting or finishing the two sides of the space, makes such space of a correct form; and just to that extent is it an improvement over the ordinary methods of cutting through on two different lines with a cutter thin enough to pass out at the thin end of the space without cutting away metal required for the finished tooth, and having the form on each of its sides correct for the larger end of the tooth.

GRUBE'S BEVEL-WHEEL CUTTER.

Of course it is well understood that, in a bevel-wheel of any proportions whatever, all straight lines through or upon them converge to a common point; and this is not only true of a single wheel, but also of a pair of any relative proportions which are to work together. This being true, in order to cut a space between two teeth in any bevel-wheel with a rotary cutter, and do it mathematically correct, the cutter itself would require to be capable of contraction in every direction proportionally to its distance from the point of convergence.

As this is practically impossible with such a cutter, a mathematically correct tooth can not be cut with such a tool, no matter what or how ingenious the contrivance may be by which it is conducted through the tooth. The small end of a correctly cut bevel-wheel must have a form homologous with the larger end, and this is impossible to be done with a rotating cutter.

In point of fact, this machine does precisely what can be done on any ordinary cutting engine by twice setting and twice cutting through a tooth space in a bevel gear, and no more, but to do this in once going round the wheel is equivalent to doing it in half the time; and as with some kinds of bevels, such as have teeth short in proportion to their depth and pitch, or such as have a straight flank and epicycloidal face—reduced as generally done to circles—a quite near approach to the correct form can be produced in this way. This little machine may be regarded as a quite marked advance in this particular branch of mechanics.

As yet there has been but one size of this machine made, and it is capable of cutting bevels of 45° or less in angle up to about 5½ inches in largest diameter, and spur and worm wheels to 16 inches diameter.

J. T. H.

INDIAN DWELLINGS AT THE EXHIBITION.

AMONG the curious exhibits is the façade of a dwelling-house of the Haidee Indians, sent to the Exhibition by Dr. J. W. Swan, a well-known collector of Indian curiosities in Alaska and British Columbia. The façade is of cedar, 18 feet high by 40 feet in width, the distance from the base to the eaves being about 14 feet. Its peculiar interest arises from

the fact that it is completely covered with grotesque paintings, representing the mythological characters of Indian religion. The tribes inhabiting the islands of the North Pacific coast have an endless number of traditions or superstitions, which are invariably symbolized by paintings or carvings on every thing they make, whether it be a house or a button. The figures are sometimes very faithfully drawn, but usually they are conventional representations of some strange idea. On each side of the door are two rudely painted whales, but these are made up of at least a dozen other animals. The body of the one on the right is filled with pictures of salmon heads, eels, human faces with glaring eyeballs; hideous figures, which may be either human or mythological. The blow-hole contains the distorted figure of a man, and on the back is a large salmon. The other whale much resembles this, except that the human faces are even more hideous. Partly above and partly on each side of the door is painted a grotesque picture somewhat resembling the human form, but the feet are represented as claws, and the hands have each a large eye in the palm. Whenever the natives paint or carve a hand, this eye always appears in the same spot and with the same number of lines, though the significance of the combination still remains a mystery. The elevation is bordered with green, dumpy pictures, supposed to be intended for human heads and bodies, with fearfully distorted limbs. The most curious part of this exhibit is the totem post, standing directly in front of the door. It is about 22 feet in height, with a large hole in the base, which serves as a vestibule to the door, and the post is carved from top to bottom with the most hideous forms imaginable. The first represents a monster bear; above this is a grotesque carving of Itl-tads-dale, the mother of the Haidalis, and on top of this are two separated dumpy reliefs, supposed to be imitations of the faces and forms on the border. To every house erected by the Haidali, or Sitkatrites, the "totem" posts are regarded as indispensable, and it is believed that every ornament and every line had at one time a significance, which may, however, have been lost in the lapse of time or only vaguely understood.

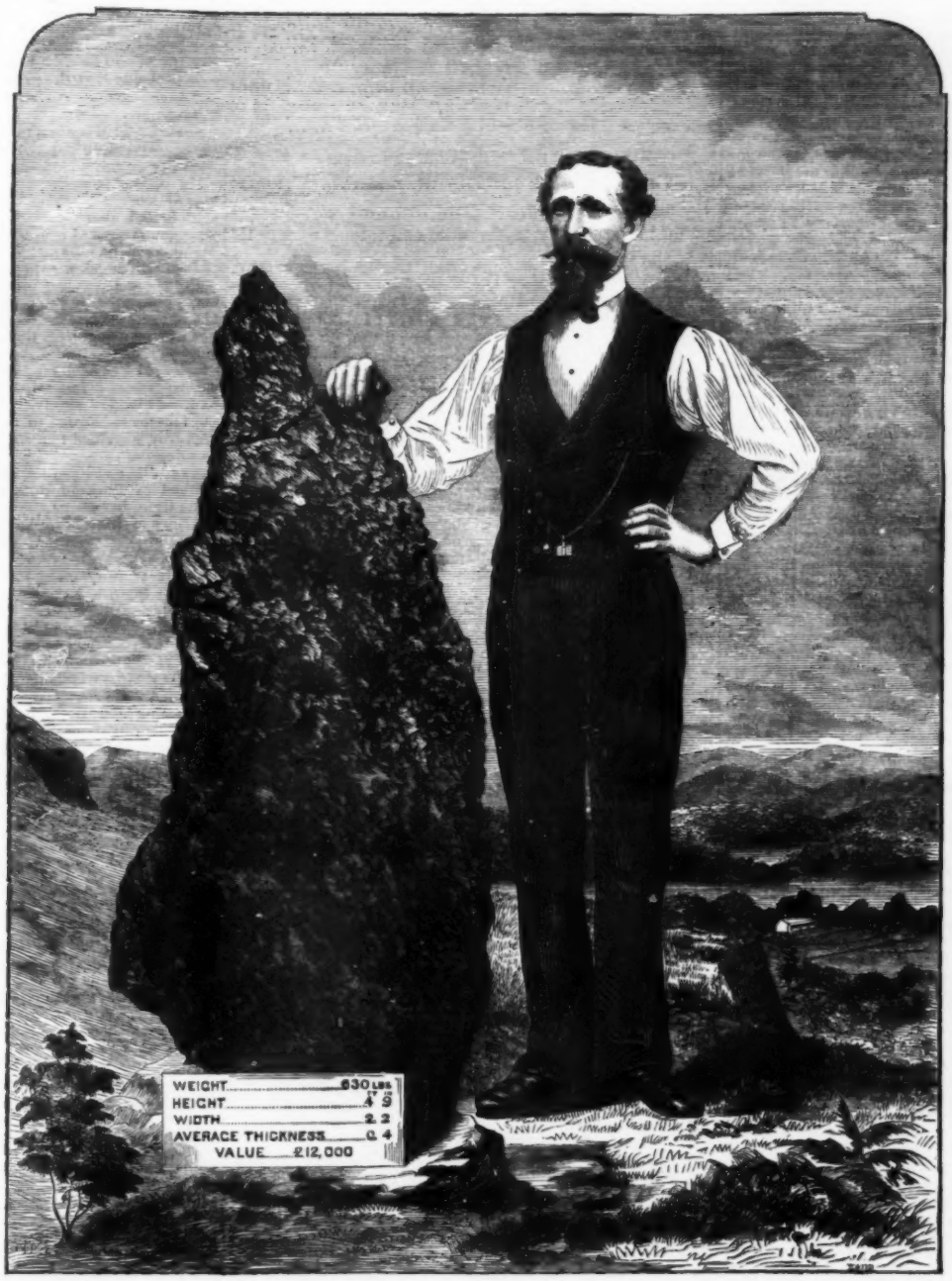
EXHIBITION NOTES.

J. D. LYNDE, of Philadelphia, exhibits a small engine which he calls "Duplex Auxiliary," the novel feature claimed being that one of the cylinders acts as assistant to the other, helping only when required, as load is put on. This is accomplished by taking steam from a T pipe to the governor of one cylinder, and from same T to the valve by which steam is supplied as necessary to the assistant cylinder. This latter valve is operated by a simple device on the principle of a steam-damper regulator, which is operated through a pipe from the working cylinder. This valve is set by a spring arrangement so that barely steam enough will pass to drive the piston; the same spring holds the operating lever from affecting the valve until the pressure is raised (by load on the engine) in working cylinder strong enough to overcome its tension, then the lever is lifted, operating the valve, and steam admitted to the assistant cylinder in quantity corresponding to the said pressure. The result is a large saving of steam where the load is constantly changing from light to heavy; as when the work is light it is about the same as changing to an engine of less than half the size. The other parts of the engine are also novel. The object has been to construct an engine which will use less steam, cost less money, and be more durable than heretofore.

AUSTRALIAN GOLD QUARTZ SPECIMEN.

AN engraving for which we are indebted to *Town and Country Journal*, represents the largest specimen of quartz and gold ever discovered in Australia, and probably in the world. It was found in Beyers' & Holterman's claim, Hill End, in 1871. On the 20th and 21st June in that year, considerable difficulty was experienced in dislodging what at first seemed a block of matrix in that celebrated claim; and after two days' work, the mass being still a fixture, crowbars were brought into requisition, and the result attendant on the labor of three men for some hours was the splendid original of our engraving, which, by the united exertions of twenty men and a horse, was brought to the surface and conveyed into Hill End, where it was exhibited to the public at a small charge for the benefit of the District Hospital.

In the accompanying engraving Mr. B. O. Holtermann, the well-known Australian gold pioneer, is represented standing beside this great nugget (which was photographed previous to its being broken up). The weight of the mass was 630 lbs., its height 4 feet 9 inches, its width 2 feet 2 inches, and its average thickness 4 inches. The value of this remarkable specimen of quartz and gold was £12,000, or $60,000.



AUSTRALIAN GOLD QUARTZ SPECIMEN.

BISMUTH.

BISMUTH is a hard, brittle metal, of a reddish white color. It is found generally in the metallic state in quartz rock, or disseminated through gneiss and clay slate. The principal localities in which it is mined are Saxony, Transylvania, and Bohemia, and recently in Peru. In this country specimens have been found in Monroe County, N. Y., in South-Carolina, at Haddam, Ct., and in Virginia. A deposit of oxide and sulphide of bismuth occurring in fissure veins is claimed to have been discovered recently, near Beaver City, Utah Territory. Its uses are limited. Its property of increasing the fusibility of those metals with which it is combined, has led to its use in the preparation of various alloys. An alloy composed of two parts of bismuth, one of lead, and one of tin, fusible at 200° Fahr., is used by die sinkers to test the perfection of their dies.

Soft solder for pewter is composed of one part of bismuth, two of tin, and one of lead. An alloy of five parts bismuth, two of tin, and three of lead, melts at 199° Fahrenheit, and is known as stereotype metal. An amalgam of twenty parts of bismuth and eighty parts mercury is used for silvering the interior of glass globes.

Of the salts of bismuth only two are commercially important, the basic, or tris-nitrate, and the oxychloride. The former is employed medicinally. It is obtained by dissolving the metal in nitric acid, and precipitating with water. It is known as "flake white;" mixed with tin and tartar it is employed as a mordant for dyeing lilac and violet in calico printing. The oxychloride is obtained by dissolving the metal in nitric acid, and pouring into it a solution of common salt. It is known as "pearl white," and is extensively used for enamels on porcelain, and also in gilding. Owing to its great solvent properties with other oxides, especially with silica and borax, to which it imparts no color, it is valuable in the manufacture of porcelain and optical glass. Its principal use, however, is as a cosmetic, to give artificial freshness to faded complexions. Sulphur turns this black. Ladies who make use of it should, therefore, avoid sulphur-baths, and contact with impure illuminating gas.

The amount of bismuth annually consumed in the United States does not exceed ten tons, the larger portion being employed in the preparation of the sub-nitrate. It is but very little used in the metal manufacture at present, owing to its high price, which is now 5s. 3d. per lb. in London, and about $1.75 per lb. here.

When the Peruvian deposits were discovered, and ore from them sent to England, a combination is said to have been made between their owners and those of the Saxon mines, to control the trade and maintain prices, on the basis of an equal distribution of sales. Should the price of bismuth be materially lowered, an impetus would undoubtedly be given to its use in the manufacture of alloys; but, even then, it is doubtful if more than fifteen or twenty tons a year could be sold in this country.—*Engineering and Mining Journal.*

Scientific American Supplement.

No. 29.

FOR THE WEEK ENDING JULY 15, 1876.

PUBLISHED WEEKLY,

AT THE

OFFICE OF THE SCIENTIFIC AMERICAN,

No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

COMBINED RATES.

The *Scientific American* and SCIENTIFIC AMERICAN SUPPLEMENT will be sent together for one year, postage free, to subscribers, on receipt of $7.00.

Remit by postal order. Address,

MUNN & CO., PUBLISHERS,

37 Park Row, New-York.

WHERE THE PROFITS GO.

THE profits of gold and silver mining are believed by many to have some of the qualities of the supernatural, and prominently, that of disappearing and leaving no trace behind them. Stern materialists deduce from this that the profits are children of the mind, fancies, delusions, and, in fact, do not exist. It is a very common mistake to discredit that which is not apparent to the senses; in fact, a sceptic should not take to himself any credit for his opinions, because it is the simplest task in the world to refuse to believe, and the daily occupation of those who are too ignorant or too prejudiced to reason or examine.

But where *do* the profits go? It is a fair question most certainly. In the great West are thousands of poverty-stricken miners, who remain impecunious from one year to another, and bid fair to continue in that state during the term of their natural lives. They are the discoverers, and mainly the workers of a large majority of mines, and so long as they remain consistently and persistently poor, there will always be a chance to accuse the business of precious metal mining as a failure.

In explanation, we will state that mining in the West is a peculiar trade, differing from all other classes of business, in that it *may* be carried on without any capital. Consequently a very large number of men seize the occupation with avidity, knowing that they can at least make their living at it, and that they have the chances of making their fortune. It is a business in which there is no competition. As a result we have a host of men working in couples or alone on a host of prospects. The work accomplished is like that done by a large army deployed as skirmishers: they cover an immense area of ground, but each man works alone, and it is just here that the profits of the business appear to disappear. They are lost, seemingly, because *so much of mining is done upon a small scale.*

Any man acquainted with business knows that large profits are the results of extensive operations; that extensive operations permit of economy in every branch of work: in fine, that it is more profitable, relatively, to produce ten thousand cases of manufactured goods per annum, than one thousand. Now apply the same principle to mining.

The problem will be to sink a shaft to a depth of 100 feet, and drive two sets of levels at the depth of 50 and 100 feet respectively; levels to be 30 feet long on each side of shaft. The mine will be one of average value, not giving much water, and in good rock that needs but little timbering: cost of sinking (including hoisting, pumping, and timbering), $20 per foot; cost of drifting, $9 per foot; cost of entire work, therefore, $3,080; production of ore, 20 tons, at $100 per ton.

When this amount of work is performed on an average mine, there will be exposed for stoping 166 fathoms of ground. Assuming the ore to be silver-bearing, and the pay vein 4 inches in width, composed of galena, zinc, and quartz, this will correspond to 270 tons of ore, *if the vein was ore-bearing throughout.* As, in fact, the proportion of paying ground to barren ground is as 1 to 4, the actual ore developed may not be calculated at over 70 tons. At the average mill-run of Clear Creek County ores, 150 ozs., which represents to the miner about $100 per ton, the production of the mine would be $7,000. Tabulated, the results and cost of the work are assumed to be as follows:

Total cost of development	$3,080
Cost of stoping 166 fathoms of ground, and marketing 70 tons of ore	3,050
Cost of marketing 20 tons of ore	400
	$6,530
90 tons of ore @ $100 per ton	9,000

It will be interesting to note how differently it is done by the miner and the capitalist.

The miner and his partner commence work with a small kit of tools, a can of powder, and a month's supply of "grub." In thirty days they have the shaft twenty feet deep, and a half ton of ore on the dump. They have had credit at the grocer's, the steel and powder dealer's, and the assayer's, and have to pay 20 to 30 per cent more than the cash dealer. Their natural sanguineness has led them to have a specimen tested at every two days' labor, and their bill for that unnecessary work amounts to as much as that for powder and fuse. At the end of the month their half ton of ore is sacked, packed down to the mill at a cost of $8 to $10 per ton, and being by nature suspicious, not only of the mill-men, but of each other, they must stay in town to see it sampled, assayed, and paid for.

When the value is known, it generally falls short by 50 per cent of their expectations, and the result is that the two, downhearted and mad, get their check cashed at the bank, and adjourn immediately to the nearest whiskey saloon, where they waste half their substance in riotous living. When the morning comes they have enough to pay about one third of their bills, and as miners are, as a rule, more honest than the majority of laborers, their last cent is deposited with the tradesman, and the balance of the day is devoted to returning to their mine. The next month's work results in about 15 feet of sinking, for water has begun to come in and much time must be spent in raising it. At the end of the third month, the partners are down to a depth of 50 feet, are heavily in debt in town, are perhaps paying three per cent per month on borrowed money or bills, are ragged, poorly sheltered, and often in sore need. They are bankrupt in every thing but hope, which never fails the true pioneer, and if their mine gives but the faintest encouragement they will not desert it. Following the record of their career, we see them putting up a rude shaft-house, with a bough roof, to protect from the winter's snow, rigging up a large-sized windlass for raising from greater depths, cutting timbers and lagging with their dull axe, and fitting them in where the walls are shaky with laborious care, using up days, where more hands could do the same work in hours; and finally, with the grit of the bull-dog, settling down to their hard work in the bottom of the shaft, following the little seam of "pay," as it pinches or expands; now buoyant with hope, now plucky for the lack of it, but always poor and ragged, roughly fed and sheltered, always paying a third more for necessities than the rich man, always working with poor tools—in fact, always under the thousand disadvantages that fall to the lot of those who have no ready means.

We are following actual records when we state that it takes a year for our miners to accomplish the development laid out. In doing it they have taken out 20 tons of ore, in lots varying from 300 to 2000 pounds. If they kept an account, it would be about as follows:

JAKE SMITH AND BILL BOOMER IN ACCOUNT WITH THE LIVELY SUSAN.—MINE ACCOUNT.

Dr.

To powder, fuse, candles, and steel	$150 00
" blacksmithing	100 00
" tools, implements, etc	100 00
" packing materials up hill	50 00
" packing ore down hill	300 00
" grocery and meat account	800 00
" tobacco, bad whiskey, and other amusements	300 00
" mill charges—crushing, sampling, and assaying	100 00
" specimen assays	50 00
" clothing	150 00
" expenses in town when selling ore	360 00
" bankers' shaves, interest, etc	150 00
" money loaned to fellow miners—nominally on interest	50 00
	$2,560 00

Cr.

By cash, for 20 tons of ore @ $100 per ton	2,000 00
Balance against the mine	$560 00

Now how does the capitalist carry on the same work? He lets a contract immediately for 100 feet; he buys steel, tools, powder, candles, and supplies of all kinds, by the quantity, pays cash, and gets them for 40 per cent cheaper than the miner; he runs up a boarding-house, boards his men, and makes a couple of dollars a week on each; his mine is a hundred feet deep in thirty days, and, by putting on more men, the levels are all driven in thirty more; he has not made any money in the work, it is true, for he has paid contract prices (which mean $5 to $8 per day to every man employed), but he has 20 tons of ore on the dump, worth $2000, and $7000 more in sight, which will net $3080: he has accomplished this, at a loss of $1080, in two months. Two months more of work will put him ahead just $2000. The miners have been a whole year accomplishing the two months' work of the other. They are five hundred dollars behind only, and have also their mine, but their debt bears ten times heavier on their shoulders than does the thousand of the capitalist's; they have yet to struggle and economize, and sink their time and labor in the ground, to work with half rations and used-up tools, till either their creditors seize their hard-earned prize, or they succeed in selling at a few hundred profit.

It will be evident where the profits go in the thousands of cases typified by this one. They are lost in the item of time. It is true that "time is money," and in no other industry can it be better exemplified than in that of mining.

All over the West there are mines in a condition of partial development waiting for a few thousands. Many will, under careful handling, yield a profit of from 2 to 10 per cent a month on sums as small as $10,000; and yet they go begging for purchasers.—*Mining Review.*

TESTS FOR IRON AND STEEL.

IRON is attacked by any of the strong acids, and that fact has been utilized as a means of testing their quality. Professor Kick, of Prague, after several experiments with nitric, sulphuric, and hydrochloric acids, and their combinations, with mordants composed of the salts of copper, etc., has arrived at the conclusion that a mixture of equal parts of hydrochloric acid and water, to which is added a trace of solution of chloride of antimony, constitutes a mordant especially applicable to the purpose. The last ingredient, which was recommended to him by Professor Gintl, renders the surface attacked more capable of resisting oxidation, and has the effect, after well washing with hot water and the application of a coat of protecting varnish composed of Damar resin, of preserving the surface attacked sufficiently pure.

The method of proceeding is always to surround the surfaces, previously prepared by means of a file or hone, with a wall of wax fully $\frac{1}{2}$ of an inch high, in the same way that copper plates are prepared for being eaten in with acid in engraving; the acid, heated to a temperature of 53° to 86° Fahr., is poured on to the surfaces, and soon begins to act, as will become manifest by the disengagement of gas. In winter, owing to the low temperature, the operation can not be performed so favorably. Its duration is usually from one to two hours, and it should be continued, as a general rule, until the texture of the iron be exposed. The progress of the action may be easily ascertained by pouring out the acid every half hour without breaking the wax border, removing by means of a brush or piece of rag the carbon (graphite) deposited on the surface, washing, and again pouring on more acid if the action appears insufficient. If the chloride of antimony has been added to the acid in proper proportion, but little time will elapse, after the action has commenced, before it will begin to throw down a black precipitate. This is easy to distinguish from the graphite, inasmuch as the latter is not very appreciable, when, for about $1\frac{1}{2}$ pint, is added only a single drop of the concentrated solution of chloride of antimony, which is sufficient.

When the action of the acid has been continued long enough the wax wall is destroyed, and the surface of the iron is washed by means of a brush with several waters, the first of which is rendered slightly alkaline by the addition of a little lye; it is then carefully dried, and a coat of varnish is applied. If at the end of a few hours there are any signs of oxidation, the varnish must be dissolved with spirit of turpentine, the oxide removed, and the varnish again applied.

The indications given by the different kinds of iron are as follows: Soft or Fibrous Iron: When of very good quality, this iron is attacked by the acid, even when the action is continued for several hours, in a manner so uniform, and with an elimination of the carbon so limited, that the surface acted upon retains a dull lustre—a few incised specks and cinder-like holes being only observable.

Fine-grained iron gives exactly the same indications; the surface generally remains uniform, but it is not quite so bright.

Coarse-grained Iron and Hot-short Iron are attacked by the acid with much greater energy than the two kinds above mentioned. Even at the end of about ten minutes the surface, especially that of the latter kind, becomes quite black. If the acid be allowed to act for nearly half an hour, a black muddy deposit (schlamm) may be removed by washing, and no amount of washing will prevent the surface from remaining black; there will also be a considerable number of small holes distributed over the surface. Some portions of the iron are generally attacked more deeply in this way; others, although they may have become black and a little porous, are better preserved. This appearance will be the more manifest if, after about an hour's action, repeated washing and drying, a fine file be passed over the surface.

Malleable Iron or Annealed Iron becomes rusty, as is well known, more readily than wrought iron; but an interesting fact is that the action of the acid is very violent and irregular.

Puddled Steel: The color, after being treated with acid and washing, is gray, and of a tolerably uniform shade, the weldings being but little apparent.

Blister Steel: The appearance exhibited is very like that of puddled steel, and the weldings are also but slightly apparent.

Bessemer Steel—Cast Steel: The surfaces of these steels are uniformly gray—the non-homogeneous parts are rare, and but little apparent. The softer the steel the more approaching to gray is the color. The action of the acid produces very fine fissures. In a sample of Mushet steel the prepared surface was perfectly uniform, but after the treatment with acid narrow transverse fissures were observed over the whole extent. It is probable that the proportion of titanium in this steel was the cause that the surface attacked presented the dark gray color.

Cast Iron: Gray cast-iron gives the same indications as steel. The attacked surface presents a tolerably uniform dark gray color. In spotted cast iron the white portions remain lighter, and the projecting particles of gray cast-iron appear distinctly, like black specks or spots. The cases enumerated above will show the indications given by the principal classes of iron when treated with acid, and therefore the phenomena afforded by pieces composed of different kinds of iron will speak for themselves.

Professor Kick has given many examples of the appearances presented by the combination of different kinds of iron, and adds: "When in the forging of any piece different qualities of iron are united, the acid, when applied to the prepared surface, chiefly attacks the quality for which it has the most affinity, and to such an extent that its mordant action on the other portions is much less active than if these portions were exposed alone or singly to the action of the acid. Bessemer steel alone, submitted to this action, presents a gray surface, but, if it is welded to a coarse-grained iron, it is attacked in a less degree."

As to the results of the action of the acid in relation to the method of working iron, the foregoing remarks show that some light has already been thrown on the choice of different qualities of iron in the arrangement of the piles; they also point out that, even with the most simple piling, there is always a considerable crushing of the bands. It is nevertheless possible to draw from the appearance of the surface acted upon by the acid a conclusion as to the position of the bands or bars occupied in the pile. The more uniform is, or may be, the distribution of the pressure in the pile, the less will individual bands become disarranged. The professor has come to the conclusion that the best method of forming the piles is that in which the welding is so perfect as to furnish the most satisfactory indications when submitted to the acid test. Professor Kick, however, admits that the samples on which he conducted his experiments were obtained from only one establishment, and that they were too few to admit of general conclusions being drawn from them; he believes, however, that he has conclusively pointed out the importance of this method of testing irons, as well for the manufacturer as for the consumer.

FRENCH ACADEMY OF SCIENCES.

MAY.

On the Action of Organic Acids on the Tungstates of Soda and of Potash. By M. J. Lefort.—Of all the mineral salts considered as neutral, according to the relations of their components, there is none which, by the test paper, exhibits so pronounced an alkaline reaction as the neutral tungstate of soda. It is known that in slightly diluted solutions of neutral tungstates of soda and of potash, the addition of certain organic acids, such as acetic, oxalic, and citric acids, cause no apparent reaction. I have found that there form in this case neutral tungstates, even in presence of a large excess of added acid. In a particular case, these organic acids may act like mineral acids—that is, to produce yellow tungstic acid. With tartaric and citric acids, the reaction, while being of the same order, is less notable, because double salts are first formed, on which the excess of organic acid has less action. Acetic acid in no case separates from the whole of the soda, neutral, or acid tungstates.

On the Adulteration of Platinum by Lead. By M. S. de Luca.—A point of platinum used on a lightning-rod, taken as a standard, had a density of 21.16 at the temperature of 57° Fah. This contained no lead, and lost none of its weight in boiling nitric acid. Two other platinum points, partially melted on lightning-rods at the Vesuvius observatory at Naples, contained from 10 to 12 per cent of lead. The presence of the latter metal facilitates fusion. The density of the mixture is, however, inferior to that of pure platinum, so that through this fact the adulteration may be recognized. Moreover, the platinum containing lead is easily recognized by the blow-pipe causing a green flame. Where platinum points are used for lightning-rods, it is recommended that care be taken that their density is at least 21.

On the Antiseptic Properties of Borax. By M. Beddin.—Having received a specimen of blood obtained from a horse having the glanders, I examined it after a lapse of one hour from the time that it escaped from the vein. It contained numerous bacteria, the movements of which were very manifest. Half of the blood was placed into a small flask with about 30 grains of powdered borax. On March 19th, the liquid was examined, and no odor or organisms was apparent. The microscope now shows no living bacteria, and the color is a fine and perfectly transparent red.

On Modifications of Electric Batteries, rendering their Construction easier and more economical. By M. Onimus.—The starting point of these modifications is the substitution of parchment-paper as a diaphragm for the porous vase. The sulphate-of-copper battery, for example, thus becomes very simple, and may be set up in an instant by any one. It suf-

fices to envelop a cylinder of zinc with a sheet of parchment-paper, and to roll in spiral form over the paper, which thus becomes a diaphragm, or copper wire. The latter holds the paper against the zinc and answers for a fastening. The whole is plunged in the sulphate-of-copper solution, and the battery soon works regularly. For some carbon batteries the carbon is enveloped in parchment-paper, and around this is placed either a zinc wire or a zinc cylinder. The battery thus constructed, when moistened, will work for some hours without entering the exciting liquid.

On Normal Pyrotartric Acid. By M. Reboul.—Present theories show the existence of four pyrotartric acids, $C^5H^6O^4$, bibasic and isomerical, derived from the hydride of propyl, $CH^3\,CH^2\,CH^2$, by the substitution of two groups, CO^2H, for two atoms of hydrogen. Three of these acids are known: the first is ordinary pyrotartric acid, or decarbonic propylene; the second is ethylmalonic acid; the third is demethylmalonic acid. This last has only been indicated, and not described. The author has prepared and studied the fourth acid, normal pyrotartric acid, or decarbonic trimethylene, $CO^2H,\,CH^2\,CH^2\,CH^2,\,CO^2H$. It is prepared with normal bromide of propylene, crystallizes by slow refrigeration of the suitably concentrated aqueous solution in triangular plates belonging to the clenorhombic type. It is very soluble in cold water, of which 1.2 parts dissolve 1 part of acid, at 57° Fah. It is soluble in all proportions in boiling water.

On the Nature of the Mineral Substances assimilated by Mushrooms. An Explanation of the so-called "Fairy Circles." By M. Cailletet.—As M. Dumas has recently observed, the mode of nutrition of mushrooms is essentially different from that of green plants. Chlorophyle plants draw from the atmosphere, under the influence of light, carbon, oxygen, and hydrogen, while inferior organisms, and the mushroom in particular, find for the same elements of their nutrition among the slightly stable compounds corresponding to those which we name "explosive bodies," compounds which themselves require for their constitution the presence of solar radiation. The ashes of mushrooms may be considered as an energetic fertilizer, by reason of the quantities of alkalic and of phosphoric acid which they contain. It is easy for this to explain the singular phenomenon of the production of the green circles which are met with in places where mousserons (a small white variety of mushroom) and others of their class grow. These circles, which popular superstition has long called fairy-rings, are traced by a thick growth of grass, the green color of which contrasts clearly with that of the adjacent herbage. The production of this is explained by the fact that a spore of the mousseron in germinating emits a mycelium which extends, following numerous radii, and forms a well-defined circle. During winter, not only does the vegetation of the mycelium stop, but it becomes greatly decomposed, thus transferring to the earth nitrogenized matters, and especially salts of potash and phosphoric acid, which it carries into the soil to quite a depth. When the spring comes, the grass and all other plants within reach of these natural fertilizers absorb them, and thus acquire a vigor and a color different from that of the surrounding vegetation.

THE MECHANICAL EFFECT OF "BLOWN-OUT SHOTS" ON VENTILATION.

By Messrs. HALL (H. M. Inspector) and CLARK.

AN opinion is frequently expressed in Lancashire and elsewhere that in blasting coal with gunpowder in a mine fairly clear of fire-damp, an explosion may result from the exhaustive action of the blast itself. It is held that a shot fired under certain conditions will relieve the atmospheric pressure on the face of the coal to such an extent that fire-damp will be instantly given off in considerable quantity, and that in very fiery seams the danger from this source is imminent. The circumstances under which this is stated to be most liable to arise are these: When in driving a narrow winning or heading, and having advanced some distance beyond the innermost holing or cut through, a charge of gunpowder is so improperly planted or insufficiently stemmed as to cause it to blow out, and spend its energy on the ventilation passing along the heading instead of doing its legitimate work of blowing the coal. Such an occurrence is locally termed a blown-out shot. It must not be confounded with that with which all miners are familiar, called in Northumberland a "standing bobby." In this latter case the powder expends itself by ripping the coal, and escapes, as it were, by distribution, without affecting the ventilation, and generally leaving the stemming in the drill-hole.

A blown-out shot would appear to attain its maximum force when it occurs in very strong coal, where a heavy charge is necessary, and the stemming has been fairly well done, so that it withstands for an instant until the exploding powder, rapidly gaining accumulated power through the heat of its own combustion, forces itself out, driving the stemming as from a cannon. We, perhaps, hear more about these shots in Lancashire than in other districts on account of the coal being so very strong, and the unfortunate practice of shooting partially fast—that is, without nicking or side-cutting—entailing heavy charges, amounting in many instances to 2¼ lbs. of gunpowder, or even more. Indeed, locally this subject has assumed very great importance, many mining men of considerable experience having given it as their opinion that some of the recent disastrous explosions have been due to this cause alone. Notably, an explosion at the Wynnstay Colliery of the New British Iron Company, near Ruabon, on April 24th, 1873, in which seven persons lost their lives. The position of the shot holes was shown by the aid of a plan of the workings, and the evidence taken at the inquest was referred to, in the course of which Mr. Thomas Bell (H. M. Inspector) said: "One of two things must have occurred; either the first shot liberated gas, which was fired by the second, or one of the shots having blown out would cause a partial vacuum in the place which would be immediately filled with gas from the cavities in the coal, and would at once become mixed with sufficient atmospheric air to make it explosive, and this might be ignited by burning embers left by the shot." The jury said: "That from the evidence before them the accident occurred from an explosion of powder arising from the drill-holes not being sufficiently bored, and the stemming being improperly secured."

The writers do not think it desirable that they should express any opinion on this particular case. It is mentioned rather to show to the Institute the very serious results that have been, and which continue to be, attributed to this cause, and it is hardly necessary to point out how highly important it is that the subject should be thoroughly investigated, with a view to proper precautions being taken if they prove to be needed. This subject has special interest at the present time, because there is a tendency to impute to blasting in mines results and dangers which it is questionable whether this operation when fairly carried out does really entail. It was with the object of gaining some reliable information as to the actual effect of blown-out shots, which are no doubt the worst aspect of blasting, that the experiments, the details of which we propose to lay before you, were undertaken, and with the hope that this beginning might lead to discussion and a thorough investigation. If it is true that people are maimed and burned by blasting at distances varying from 10 to 180 yards, when there is no fire-damp present to cause such destruction, then it is quite clear that this results, either from the simple force and flame of the shot on account of the weight of the charge; or, from this force and flame assisted by the rapid combustion of coal dust as it travels on its course, or from the force and flame assisted by an instantaneous emission of gas, in consequence of a partial vaccum being formed by the rushing blast.

With a view to testing the first of these assumptions—that the havoc is caused by the unassisted gunpowder contained in the charge—varying charges were fired from a strong iron tube, 2 ft. long, and 2½ in. diameter, at the face of a slant or adit which had been driven down from the surface and arched with brickwork a distance of 45 yards; its sectional area was 30 ft., which would fairly represent a winning or heading. The stemming was done with small debris, and the mouth of the cannon directed so that the discharge might pass freely up the slant. Gauze sheets of thin and easily inflammable material were suspended at intervals of 15 ft., by means of cross-pieces of timber reaching from about two thirds the height of the arching nearly down to the thill, and in each cross-piece small holes (1 in. diameter and 2 in. deep) were drilled so as to face the blast, and these were filled with fine gunpowder.

Experiment No. 1.—Fired 1½ lbs. powder: canvas and cross-piece at 15 ft. knocked down, but no appearance of flame having reached this distance.

Experiment No. 2.—Fired 2 lbs. powder: canvas and cross-piece at 15 ft. knocked down, but no appearance of flame having passed.

Experiment No. 3.—Fired 2½ lbs. powder: canvas and cross-piece knocked down at 15 and 30 ft., but no appearance of flame.

Experiment No. 4.—Fired 2 lbs. powder: canvas and powder burnt at 15 ft.

Experiment No. 5.—Fired 2½ lbs. powder: canvas and cross-piece knocked down at 15 and 30 ft., but no appearance of flame.

These experiments were continued, but in no case was either canvas or the powder burnt beyond 5 yards from the point where the shots were fired. The tube was afterwards stemmed very tight so as to cause the explosion to burst it, but the flame travelled no further in this case. The blast at the mouth of the slant (45 yards) was certainly perceptible, but comparatively unimportant.

To test the second assumption—that the force and flame are assisted by the rapid combustion of coal dust as it travels on its course—a similar tube was used, the stemming in this case being small coal; gauze sheets and gunpowder were fixed, as before, at intervals of 15 ft. in the slant; the thill for 8 or 9 yards from the face was thinly covered with coal dust obtained from the screens.

Experiment No. 1.—Fired 1½ lbs. powder: canvas and powder at 15 and 30 ft. burnt; at 45 ft. not burnt; blast at mouth of slant very strong.

Experiment No. 2.—Fired 2 lbs. powder: canvas and powder at 15, 30, and 45 ft. burnt; at 60 ft. not burnt; blast very strong, knocking down the three nearest cross-pieces.

Experiment No. 3.—Fired 2½ lbs. powder: canvas and powder at 15, 30, 45, and 60 ft. all burnt; blast at the mouth of the slant, a distance of 45 yards, very fierce, lifting and driving a metal pipe, weighing nearly ¼ cwt., 15 yards, and moving a coal tub on the pit heap, 75 yards distant.

Experiment No. 4.—Coal dust having been scattered on deals the whole length of the slant (the hill being very wet), fired 2½ lbs. of powder; in this case flame issued strongly at the mouth of the slant, having travelled 45 yards. The blast was very fierce, and would certainly have proved fatal to any one struck by it in its course. It was noticeable in these experiments that not only the flame was largely increased, but the blast was also proportionately greater. And bearing in mind that the floor of the slant was very wet, the roof dripping, and the temperature low (50°), we may fairly assume that in dry mines, at a high temperature, and where the roads are always thickly covered with fine dust, this dust will play a considerable part in extending and adding to the destructiveness of an explosion.

To pass now to the first part of the third assumption—on any partial vacuum being formed in a colliery working there is an instantaneous emission of fire-damp. It is, of course, well known that any relief of atmospheric pressure causes fire-damp to be given off more freely; but since natural variations of this description are gradual, and occur within narrow limits, it is usually quite practicable to deal with them without much difficulty. But the assumed condition is much more serious than this, and, at any rate, may be supposed to amount to a relief of one half the natural pressure, or 7 or 8 lbs. per square inch, and this occurring in an instant. For the purpose of testing the result of such a sudden and unusual occurrence in a mine, a wrought-iron pipe, 4 in. diameter and 4 ft. long, was procured, and fitted with a piston and a vacuum-gauge. This instrument when tried experimentally registered a vacuum of 13 lbs. It was then taken underground, and a hole having been drilled 18 in. deep into the coal on the side of a level in the Bastian seam (360 yards deep), was inserted and wedged as air-tight as possible with wooden wedges. On the piston being drawn once rapidly back, the gauge registered 2½ lbs. for an instant, but the issuing fire-damp seemed immediately to fill the tube, and quickly balanced the outside pressure. Then forcing the piston forward, fire-damp was driven in large quantities through the coal in various places at some distance from the point where the pipe was fixed, and on being lighted had the appearance which they illustrated. The gauge was now taken off, and the fire-damp allowed to escape through the aperture; the issuing gas was in this case sufficient to feed a flame 3 ft. long. The pipe was next inserted in the face of a heading in the Wigan Nine-feet, one of the most fiery seams known (190 yards deep); on the piston being drawn back, fire-damp followed instantly, no vacuum being shown. On account of the dangerous character of the seam, we did not attempt to burn the gas on making the return stroke, but there was evidently a large quantity forced through the coal, as in the last experiment. The next trial was in the Pemberton Four-feet (240 yards deep), a seam considered to make very little gas, but the result was the same, large quantities being driven out, and it was then lighted.

Although the superficial area of coal exhausted in these experiments was very small, amounting only to a few inches, the quantity of fire damp given off was very remarkable; great care was taken to burn it, yet in one instance a rather serious quantity collected about the roof. The writers have not as yet succeeded in proving an affirmative as regards the second part of the third assumption—that a partial vacuum is formed by the rushing blast from a blown-out shot. The following experiments with this object have been carried out. A boiler was procured 24 ft. long and 6 ft. diameter, and having closed all the openings with the exception of one end, a vacuum gauge was attached, and charges of powder varying from ½ to 1 lb. fired from a tube fixed at the closed end, and so directed that the blast might pass freely toward the open end. A number of shots were fired, but in no case did the gauge register any vacuum. A small mercurial gauge was also fitted on, but this was put out of order by the vibration. Having failed with the boiler, the downcast pit, in connection with the slant, was next closely covered with deals and sand, and 2½ lbs. of powder fired, but the gauge still refused to show any relief of pressure. It was noticeable in this last experiment that through the ventilation being entirely cut off, the effect of the shot was very slight as compared with similar charges fired when the air was passing freely. We hope at some future time to carry these experiments further, and record the result, as it seems quite impossible that there should not be a considerable relief of pressure, maybe only for an instant, but still appreciable, because the expanding gases from the powder come in contact with the air passing as ventilation after having attained considerable velocity, and must necessarily reverse its direction, and meantime these gases are cooling down, and their pressure rapidly diminishing.

In conclusion, the writers feel confidence in submitting as the result of their observations and experiments:

1. That flame from a blown-out shot, unassisted by gas or coal-dust, does not travel further than 5 or, at the utmost, 10 yards, entailing little or no danger.

2. If coal-dust be present even in a comparatively damp mine, this flame may travel 50 yards; that in a dry mine of a high temperature this distance would be greatly exceeded; and since miners, as a rule, consider themselves safe at from 15 to 20 yards from the point where the powder is being used, a blown-out shot, under these circumstances, is a source of great danger.

3. That the violence of the blast from either gunpowder or fire-damp is much increased when coal-dust is present.

4. That on any partial vacuum being formed in an underground coal working, fire-damp will instantly issue in dangerous quantity; and there are fair grounds for assuming that a shot blowing out in the face of a narrow heading, and setting coal-dust on fire in its course, would by its exhaustive action produce such a vacuum, and might cause a serious explosion in a mine practically clear of gas.

5. Although no experiments have been made directly to test the result of coal-dust set on fire in air heavily loaded with fire-damp, there is every likelihood that such an occurrence would be attended with grave consequences.

6. That it is desirable that any system of blasting coal which entails heavy charges of gunpowder and an unusual liability to shots blowing out, such as blasting without side-cutting, or nicking, or using improper material for stemming, should be discontinued.

7. A large body of flame, such as results from a very heavy charge or from a blown-out shot, is required to ignite coal-dust; that in blasting with charges not exceeding 12 ozs., accompanied by the proper preparation of holing and side-cutting, there is little liability of this taking place. As these experiments progressed the important part which coal-dust seemed to play was forced upon the writer's attention.

WORK STORED UP IN COAL.

We find some interesting remarks as to the amount of work stored up in coal in a paper forming part of the Philosophical Transactions of the Royal Society, published in November, 1875, contributed by Captain Noble and Mr. F. A. Abel, entitled "Fired Gunpowder." They state: "It is interesting to compare the above work of gunpowder with the total theoretic work of 1 gramme of coal, which is about 3,400,000 gramme units. The work stored up in 1 gramme of coal is, therefore, more than ten times as great as that stored up in 1 gramme of powder (332,128 gramme metres). The powder, it is true, contains all the oxygen necessary for its own combustion, while the coal draws nearly 3 grammes of oxygen from the air. Even allowing, however, for this, there is a considerable inferiority in the work done by gunpowder, which is, doubtless, in part due to the fact that the coal finds its oxygen already in the form of gas, while a considerable amount of work is expended by the gunpowder in placing its oxygen in a similar condition. In an economic point of view, also, the oxygen stored up in the gunpowder is of no importance, as that consumed by coal costs nothing, while the oxygen in the powder is in a most expensive form. The fact is, perhaps, worth noting as demonstrating the impracticability of making economic engines deriving their motive power from the force of gunpowder." Now, it would appear to follow from these remarks that if coal could be consumed with a rapidity at all approaching that of gunpowder, then it would partake somewhat of the nature of an explosive. Perhaps the fact that it has to obtain its oxygen from the surrounding air is in the way of its attaining any thing like instantaneous combustion, but we must bear in mind that, when finely disseminated in air of a high temperature, it is certainly in a condition most favorable to rapid combustion.

NEW TORPEDO CARRIAGE.

A NEW description of iron carriage is being manufactured in the Royal Carriage Department, Woolwich. It is for the purpose of utilizing the discovery recently made that the fish torpedo can be discharged into the water from a ship's deck as successfully as it has hitherto been despatched from a tube in the ship's bows under the water-line. The carriage has a tubular frame to hold the torpedo, which is projected from it through either of the portholes by hydraulic pressure, and has its air-engine set in motion by a simple plan. The buoyancy of the torpedo having been previously regulated, it is found by experiment never to fail in rising after its dive, and going straight ahead to the object aimed at.

HYDRAULIC MOTIVE-POWER ENGINES.

THE invention of Mr. H. Hilditch, of Wolverhampton, England, consists in obtaining motive power from a descending column of water by arranging within a case a wheel similar to an ordinary water-wheel, and causing the column of water to be divided into four or other number of small columns, which are delivered at equidistant points on the wheel. At or near the points in the case where the small columns of water enter are packings for preventing the back action of the water, and also outlets for the water. The space between the wheel and case is thus kept filled with water having the pressure of the original column. Valves are used for determining the amount of water entering the engine, and these valves may be operated by a governor.

MACHINES FOR MAKING PORCELAIN PLATES.

THE annexed engravings, extracted from the *Bulletin de la Société d'Encouragement pour l'industrie nationale*, represent some new machinery for the manufacture of porcelain plates, devised by M. Faure, of Limoges, France. In order to understand the capabilities of the apparatus, it is necessary briefly to review the operation of plate-making as now practised mainly by hand.

To produce the plate, three distinct operations are necessary—the forming, the moulding, and the turning. The forming (*ébauchage*) consists in giving to the soft paste an approximate form. The workman taking a ball of the plastic mass places it on a wooden disk, the centre of which coincides with that of his wheel. He then flattens the mass until it assumes a lenticular shape, the molecules being pressed to follow a spiral from the centre outward. This is then put in a dry place for a short period. Moulding consists in forcing the mass formed as above into a mould, which imparts to it the exterior form of the plate. By means of a dampened sponge the workman presses on the paste until it takes the imprint, working always from centre outward, and leaving enough material wherewith to form the base portion. With a knife he removes the excess of material and then places the plate in a drying chamber, where it becomes sufficiently solid to be removed from the mould. It is then about twice the thickness to which it ultimately must be reduced.

The turning operation brings the object to its proper dimensions. A cutting tool is used to remove the excess, and the diameter of the plate being traced with a compass, it is removed and finished by thinning the edges. The plate is then ready for baking.

The difficulty in the above is that peculiar to all hand-work —namely, variability. No two workmen exercise exactly the same pressure, and consequently, even with the same moulds and material, no two can produce exactly similar plates. All this is, however, claimed to be effected in the present machine, which combines three different tools.

Figures 1 and 2 exhibit side and front views of the apparatus for making *croûtes*—or their flat disks of paste. A is the lathe head made of plaster mortar, formed on the iron armature *a*. B is a piece of sheepskin extended on a copper circle. C is the calibrating tool which spreads the paste. D is the tool arbor. This is lifted by a cord and pedal, and descends by its own weight. E is a stop limiting the descent, which is also adjusted by the device at F. The plastic material is placed in ball-shape on B, and the lathe set in motion by pressing a pedal. A second pedal-pressed tool descends vertically, with an accelerated velocity at the beginning, stops a few seconds for the operator to centre the ball with the palm of the hand and hold it so as to resist the centrifugal force, and then continues its travel with slackened speed. At the end of its movement the tool has reduced the paste into a cake, of a surface and volume conforming to that which the plate ultimately is to possess. As soon as one *croûte* is prepared the tool rises, and a second ball of paste is inserted and so on.

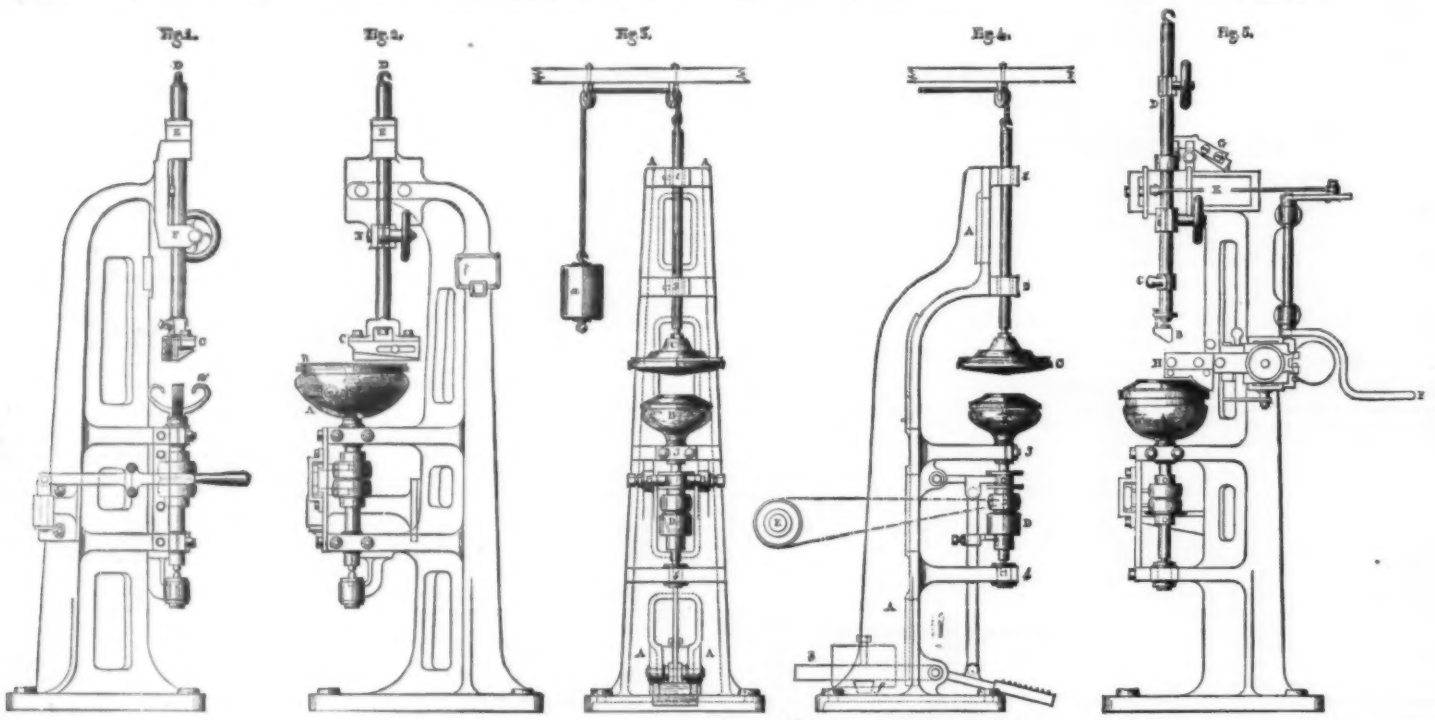
The second apparatus, as shown in the front and side views (Figs. 3 and 4), serves to replace the *croûte* in the axis of the lathe without deviation of the centre, when turned over to be brought in contact with the mould. A is a cast-iron frame carrying four collars, 1, 2, 3, 4, the axes of which coincide. The pair above guide the tool arbor; these below the lathe spindle. B is the lathe head surmounted by the mould. C is a platform to which is secured the sheepskin circle to which the *croûte* is attached. By carrying this platform down, the *croûte* is brought in contact with the mould. When the *croûte* is detached the platform and sheepskin is lifted by the counter weight *a*. D is a friction gear thrown into action by the counterweighted pedal *b*. This serves to throw the lathe into or out of motion at will. E is the motor.

The third apparatus, of which a front view is given in Fig. 5, consists of a vertical frame carrying the lathe below, a calibrating tool in the centre and the moulding tool above. The *croûte* A coming from the second machine is secured to the lathe head. B is the moulding tool moved by the handle C. D is an adjusting collar. E a carriage regulating the movement of the tool effected by the handle F. G is a gauge for regulating the form of the plate. H is the calibrating tool. The *croûte* being on the lathe head the tool is caused to descend, and this meets the paste at the centre, determining its thickness. Being restricted in its motion by the guide or gauge G which represents the profile of the plate, and being submitted to a horizontal movement, it necessarily works the object according to the desired exterior form indicated by the gauge.

If what we have said about hand moulding be recalled, it is evident that the tool should exercise, on the bottom and rim, pressures to certain relation. These are, however, dependent on the section of the *croûte*, and this by the first machine is perfectly regulated. Regarding the shaping of the edges, the tool acting at a determined angle and with helicordal faces cuts the paste while compressing it, and represents the work of the hand regulated and perfected.

The calibrating gives the polish and produces the raised portions which decorate the piece. The tool merely polishes without pressing, and this terminated, a special tool removes the material which extends over the edges of the mould. The workman then lightly lifts the extreme edge so as to facilitate withdrawal, and removes the mould to a warm place for drying, as already explained.

With regard to production, by hand work alone about 100 plates per day can be made. A single workman, aided by two children, can by the above machine average 450 per day.



MACHINES FOR MAKING PORCELAIN PLATES.

THE PREPARATION OF DRY PLATES.

By Professor H. VOGEL.

IT is a singular fact that many photographers have a particular aversion to the adoption of a dry process. Even when the matter is put before them in the most favorable manner, they will hear nothing of it. They have no confidence in the process nor in themselves, and I have often been amused at the timidity shown by old photographers in my presence when they conduct the manipulations of some dry process or other. Most of them believe that a particular routine and special experience are necessary, as also that something of a secret character is wanted. If I make mention of alkaline development, then they at once assume there is something mysterious in the matter. Only very recently I had a couple of these anxious gentlemen in my studio, who would have nothing to do with dry plates, and into whom I managed to infuse courage in a singular manner. At the same time a young pupil entered my laboratory, who came quite ignorant upon photographic matters, but who turned out a very apt scholar; and in order to prove to the two gentlemen that the preparation of dry plates involved no mystery, I permitted this young fellow, after he had had a little practice in the collodionizing and sensitizing of plates, to prepare some dry plates forthwith, and, behold, they turned out excellently well.

Every well-prepared portrait plate produced by the aid of good chemicals may be transformed into a dry plate. You have nothing else to do, after it has been sensitized in the silver bath, but to wash it in a dish of distilled water, and as soon as the marks of grease have disappeared, to rinse it under a tap, the back and front being afterwards again washed with distilled water. Finally, there is poured over the film an aqueous filtered solution of tannin of two per cent strength, a little of the fresh clear liquid being taken for every plate. This is all. To develop, you simply moisten the plate with alcohol, not too strong, wash it under the tap, and treat it with ordinary pyrogallic acid and silver solution, such as is employed for intensifying purposes.

I am far from recommending the use of dry plates for every purpose where wet plates are employed. There are, however, occasions when you have neither the desire nor opportunity of carrying with you the whole collection of apparatus necessary for dry plates, and when a moderate result will satisfy you, for in quality dry plates are much inferior to wet ones. All the big photographers of Venice take their architectural pictures upon dry plates.

As a matter of course, dry plates will not retain their sensitiveness for ever; their sensitiveness becomes less daily, and for this reason it is advisable to employ them before they are too old.

As simple as the above is the preparation of bromide of silver plates to be developed by means of an alkaline solution. You prepare for the purpose a strong silver bath, made up of—

Water	100 grammes.
Nitrate of silver	12 "
Nitric acid	3 drops.

Into this bath are immersed for a period of five minutes the plates which have been coated with collodion prepared according to this formula:—

Bromide of cadmium	2 grammes.
Alcohol	30 "

A solution is made, and this is added to—

Normal collodion (2 per cent of pyroxiline)	90 grammes.

After sensitizing, the plates are as carefully washed as before described. In this case, however, a film of tannin is not only unnecessary, but actually injurious to the plate.

These bromide-of-silver plates are only about a fourth as sensitive as wet plates, and require, therefore, to be exposed four times as long as an ordinary wet collodion film.

The alkaline development, all said and done, is a very simple affair. The exposed plate is moistened with alcohol as described above, then rinsed under a tap, and treated with the undermentioned solution, namely:—

Alcoholic pyrogallic acid solution (10 per cent strength)	½ cub. cent.
Ammonia	3 drops.
Bromide of potassium solution (25 per cent strength)	1 drop.
Water	10 cub. cents.

If the plate has been properly exposed the image will at once become apparent, and strengthen of itself on further treatment. The developer soon becomes a brownish tint, but this is a matter of no moment. The fixing is undertaken in the ordinary way.

Bromide plates of this kind work better than tannin plates. If photographers will only try the process they will succeed straight off. Clean manipulation is, of course, necessary. Those who are unable to produce clean wet plates should not take to dry-plate photography. Emulsion plates are rather more difficult of preparation, but the careful operator will find them as easy to produce as wet plates. The Singer dry process is most to be recommended; it is the simplest of all, gives good results, and the plates are little inferior to wet ones.—*Photographische Notizen.*

CEMENT FOR FIXING INDIA-RUBBER TO METAL, ETC.

A GOOD cement, that will render india-rubber in any form adherent to glass or metal, is ofttimes a desideratum with photographers, and in the *Polytechnisches Journal* for last month there is a simple recipe given for the preparation of such a compound. Some shellac is pulverized, and then softened in ten times its weight of strong ammonia, whereby a transparent mass is obtained, which becomes fluid after keeping some little time, without the use of hot water. In three or four weeks the mixture is perfectly liquid, and, when applied, it will be found to soften the rubber. We are told that the rubber hardens as soon as the ammonia has evaporated again, and thus becomes impervious both to gases and to liquids. For cementing the rubber sheet, or the material in any shape, to metal, glass, and other such surfaces, this cement is strongly recommended.

PREPARATION OF GLASS PHOTOGRAPHS FOR COLORS.

BY G. C. LEWIS, WASHINGTON, D. C.

I TAKE gum-arabic, dextrine, gelatine, or other similar substance, and combine it with honey, grape-sugar, glycerine, or other similar hygroscopic substance. In practice I find a solution of gum-arabic and honey to answer admirably. These substances I use in equal proportions, with or without the addition of water, according to the thickness and strength of the required coating. I apply the compound to the glass plate after fixing and washing, flowing it over the surface until the whole is evenly covered, after which I dry the whole by natural or artificial heat.

The surface thus produced upon the plate will be extremely adhesive, and will have sufficient strength to sustain the coloring matter and the rubbing necessary to apply the same. The gum forms the ground or base of the coating or surface, while the honey or hygroscopic material effectually prevents any tendency of the gum to crack or chip off.

The finished pictures formed by this process are termed "chromotypes."

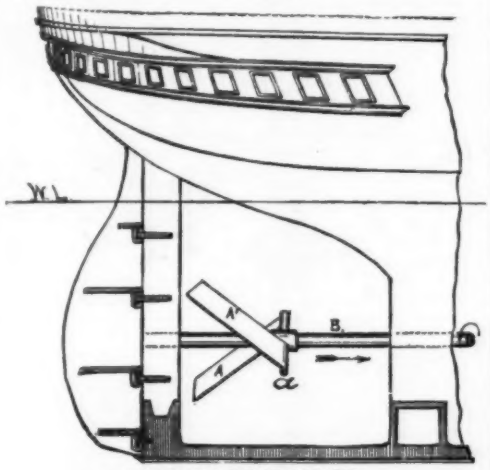
NEW PROPELLER.

By THOMAS M. RANKIN, Modesto, Cal.

THE object is the production of a substitute for the screw-propeller which will reduce the jar or vibration of the hull, caused by the blades of the screw acting improperly upon the water, and remove the liability of breaking either of the blades.

The new propeller consists essentially of two blades, A A′, fixed upon a shaft, *a*, at an angle with each other, and connected with and secured to the driving-shaft B. The blades A A′ are made of thin metal, of a strength and thickness proportionate to the size of propeller, either in one piece or of several sheets of metal, riveted together and strengthened by means of ribs and flanges to hold them in shape against the action of the water. They are secured to the shaft *a* either in a fixed manner or by devices that will permit them to be adjusted and held at any angle with each other.

Blade A′ is fixed to the shaft *a*, while the other, A, is adjustable around it, and thus, in adjusting the propeller to the vessel and to the work required from it, the angle between the faces of the blades can be changed as desired. The shaft *a* passes through the collar or enlarged portion of the driving-



RANKIN'S NEW PROPELLER.

shaft B, and is held always perpendicularly to the driving-shaft, but yet with sufficient play to permit the shaft *a* to turn, or rotate, in it; so that, although the motion of the blades around the driving-shaft is always positive, and in a circle, of which the shaft and collar is the centre, yet the blades and their shaft *a* are free to turn, as the water in which they are immersed acts upon their surface with different degrees and changes of pressure.

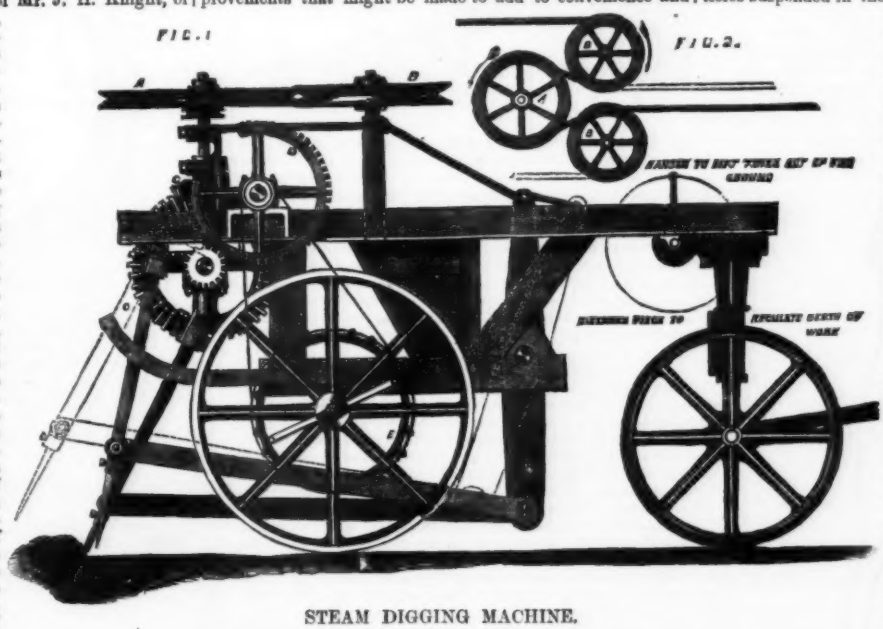
Where, from the rolling and pitching of the vessel, one of the blades may be exposed above the water, this principle of adjustment will prevent any injury to the propeller by the breaking of the blades, for, as the blade again enters the water it will assume a position of least resistance and cut into the water, instead of striking against it and forcing its way below the surface by displacement.

STEAM DIGGING MACHINE.

IN the accompanying engraving we illustrate a machine for digging hop-gardens, the invention of Mr. J. H. Knight, of Weybourne House, Farnham, Eng., which has been in successful operation for some time. This implement is not intended to come into competition in any way with the ploughs, digging-breasts, and cultivators for open agricultural work. It is specially intended for hop gardening. The accompanying Figs. 1 and 2 so far speak for themselves that a very few words of explanation need be given. The machine is driven by a rope running over the three pulleys, as shown in Fig. 2, placed on the top of the implement, A and B, in Fig 1. The implement is then impelled forward, and the forks are driven, when required to work, simultaneously. The pulley A in both Figs is the main driving part, the pulleys B B being merely employed to give the rope a sufficient grip. The power is further communicated by the wheel D to the main axle, a notch-pulley E and a pitch-chain. There are three forks hung on as many loops of the crank, the loops being at different angles, as shown by the positions of the forks *c c c*. The upper part of each fork-staff describes a circle with the revolution of the crank, as a matter of course; but as the fork-staff is held by an arm one fourth of its whole length from the bottom, the figure described by the point of the fork is not a corresponding circle, but an oval. By throwing the carrier of the arms forward at the top, the bottom is thrown back in a corresponding manner, when an oblique instead of a perpendicular thrust is given to the forks. With the forks held in the position of the dotted lines the depth they would enter the soil would of course be less, while the angle at which the spits of soil would be picked would also proportionately differ. The forks may be lifted entirely free from the surface by the same means, for doing which there is a handle, as notified on the top to the right of Fig. 1.—*The Engineer.*

FIG. 1

FIG. 2.



STEAM DIGGING MACHINE.

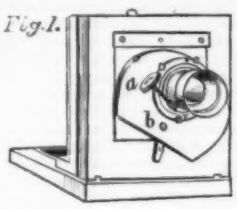
RUSSIAN RAILWAYS.

THE aggregate length of railway in operation in Russia at the commencement of 1876 was 17,658 versts, as compared with 16,933 versts at the commencement of 1875. The aggregate traffic receipts of all the Russian lines last year were 141,013,278 roubles, as compared with 140,933,789 roubles in 1874.

NEW MULTIPLYING CAMERA.

FIG. 1 shows the front view of the box, with the lens placed in position for making an image on one end of the plate, the plate being placed horizontally. The lens is brought into position for the other end of the plate by moving it to that side, the piece to which the end is fastened (*a*, Fig. 1) rotating on the screw *b* (Fig. 1), thus describing an arc of a circle around the point *b*.

Fig. 1.



"Now, how to make one. First make a flange head to fit the box you wish to use; then take a plate the size you wish to work—a one-fourth size, for instance—and draw lines as in Fig. 2, thus finding the centres, *c c*, of the two halves. Now measure the distance from *c* to *c*. Find the centre of the flange head *c*, Fig. 3. Then mark a point at the right and one at the left of this centre, both the same distance from it, and from each other the same distance that the points *c* and *c* (Fig. 2) are apart.

Fig. 2.

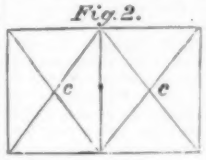
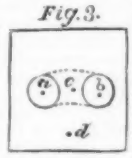


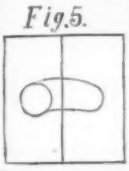
Fig. 3.



Around each of these points (*a* and *b*, Fig. 3) describe circles the size of the back end of the lens, or a little larger, to permit of the lens working freely. Mark a point *d*, Fig. 3, exactly under the centre of the flange head. This is where the screw is placed on which the piece to which the lens is fastened moves. Next cut out the small circles, and that part between them and the dotted lines (Fig. 3), and you have the flange-head properly made. Now take a piece of pine or other wood one fourth or three eighths of an inch thick, wide enough to extend a little below *d* and a little above the opening (Fig. 3), and about twice as long as the opening, something like Fig. 4. Mark a point equidistant from the ends, and near the bottom, *a* (Fig. 4); also another, *b* (Fig. 4), exactly above it, the same distance from it that *d* is from *a* or *b* (Fig. 3). Around this last point, *b* (Fig. 4) describe a circle the size to admit the free working of the back end of the lens, and cut it out. Around *a* (Fig. 4) describe the part of a circle at the top, as shown by the dotted lines, and trim off the outer part to the circle, also the lower corners, if desired. Make a hole at *a* (Fig. 4), for the screw to pass through, and fasten the screw to the flange head at *d* (Fig. 3), and the apparatus is ready for the lens, which can be very conveniently fastened on by three or four small screw-eyes, by which arrangement it can be removed in less than half a minute, and fastened in the same way to any other flange-head you may wish to use. Put into the flange-head two screws close to the top edge of the piece to which the lens is fastened, which will prevent the weight of the lens from pulling it forward and letting in the light. Some other device may answer in the place of the screws. Now make and place the cut-off, which is a partition in the camera (Fig. 5) to keep the two images from blending, and you have your apparatus ready for business.

Fig. 4.

Fig. 5.



"We have described the one we are now using, and the first one we made. It is rudely constructed, but works satisfactorily, and has for six months. We use a one-half camera and a one-fourth lens. There are many little improvements that might be made to add to convenience and looks. Ours is made of pine. They can be made of some metal, and, perhaps, would work better. Be particular that the lens is the same distance from the ground-glass in both positions. If you find you are out of focus on one side, take the lens off, and make a careful measurement from the ground glass to the outside edge of the piece to which the lens is fastened, and if there is any difference, make the correction. If you are still out of focus, it may be that the sensitive surface of the plate in the plateholder, when the tablet is in position, does not come in the same plane with the inside surface of the ground glass. The remedy for this is simple.

"We also have one constructed by which we can take four pictures on a half-size plate, using a 4-4 camera box and a one-fourth size lens. But, as we have already occupied so much of your valuable space, we will not describe it. However, if any of your readers desire a description of it, we will give it to you for publication.

"The advantages of this contrivance are many. Nearly every photographer has a one-fourth size lens. With this size he can construct the apparatus himself, which will do all the work of a double or four-tube lens of one-fourth size, and thus save an outlay of money for such lenses, which is quite an item with the poor man. It can supplant the little ninth-size gem tubes now used by so many, and which all will admit are generally inferior instruments, thus making a gain of quality of work done without purchasing new instruments. Furthermore, it gives the advantage of a change of position or subject at each exposure.

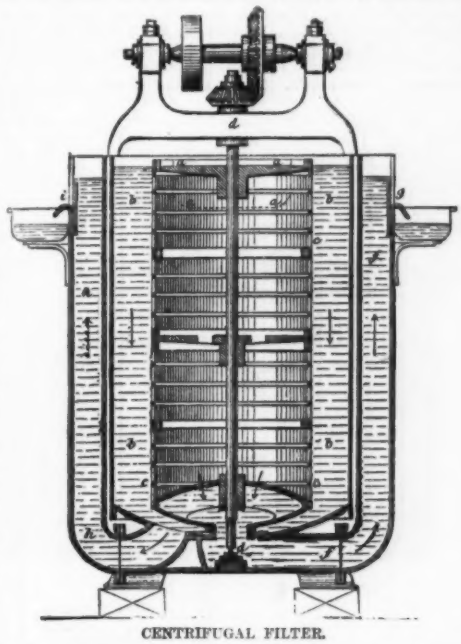
"It can also be used as a stereoscopic lens with success in all cases where there are no moving objects, by simply making the two points of exposure to suit the size of the plate. In order to use it as such, it will be necessary to make a separate one for the purpose.

"Now, finally, if this proves an advantage to only a few of your readers, we will feel greatly rewarded for the little trouble to which we have been in writing this article.

"Let others who have anything which they think is good, and which will be a saving of time and money, come out with it, and let all be the partakers of the benefits."—*Philadelphia Photographer.*

A CENTRIFUGAL FILTER.

THIS ingenious filter, by MM. Autier and Allaire, is one of altogether novel construction, its efficiency not depending on the use of any filtering matter, but on the application of a simple mechanical action. Its construction is based on the principle that if a cylinder be set revolving rapidly in a fluid in which solid particles are suspended, the fluid participates in the velocity given to the cylinder, that next it revolving at the highest speed, and the remainder of the fluid at ratios the inverse of their distance from the cylinder. The solid particles suspended in the fluid are thus driven away from the neighborhood of the cylinder, where the fluid is left clear, in which condition it can be led away by properly placed draw-off pipes.



CENTRIFUGAL FILTER.

The apparatus consists of a receiver, *b b*, into which the impure liquor flows over from the shoot, *a a*. In the middle of the receiver is a cylinder, *c c*, fixed on a vertical shaft, capable of receiving a high velocity from the action of the toothed wheels shown overhead. Circular openings are made in the walls of the cylinder, through which the filtered fluid from its outer surface passes into the interior, where it is collected, flowing out in the direction of the arrows at *c c*, through the opening, *d*, into the tube, *f f*, which leads it up to the tap at *g*. The outflow at *g* is regulated by a slide piece. The solid particles in the fluid thrown out to its exterior circumference next the walls of the receiver gradually sink, on account of the smaller velocity of the fluid and their own weight. They collect in the tube, *h h*, following the direction of the arrows, and leave the apparatus at the exit port, *i*, which, like *g*, is regulated by a slide.

The simplicity and economy of this apparatus adapt it for use in sugar refineries, paper mills, or other works in which water is used on a large scale. The degree of purity can be regulated by the amount of rotation given to the vertical shaft or by the degree of opening given to the ports at *g* and *i*. Every establishment which uses steam, even on a moderate scale, can make use of this new apparatus, which is driven at a small expenditure of power. There will be seasons, as for instance during a period of flood, when the purification of river water for drinking purposes may be materially assisted by this centrifugal apparatus, but its action is purely mechanical, and amounts only to a quickening of purification by deposition of sediment. Driven by water-power, the cost of the apparatus would be little in excess of the first outlay. —*La Nature.*

SILVER DUST.

THE ore from the Consolidated Virginia Mine is wet down as it is deposited in the ore-house, to save the dust, which is fine chloride of silver and valuable; and in the California mine the ore is sprinkled in the breasts, with the same object.

NEW ELECTRIC PROBE AND EXTRACTOR.

M. TROUVÉ has recently devised a novel and very ingenious electric probe and extractor, the construction of which is based on the fact of the greater conductibility of metals compared with that of liquids and parts of the human body. It consists of four distinct parts—the battery, the exploring probe, the revealing apparatus, and the extractor. The battery is represented full size in Fig. 1, and is composed of a zinc carbon couple enclosed in a hard-rubber case hermetically sealed. The zinc and carbon occupy one half the vessel, and the remainder is filled with the exciting liquid bisulphate of mercury. As long as the battery is carried as shown in the engraving, the

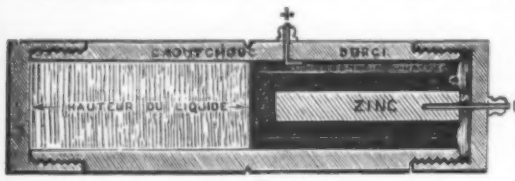


FIG. 1.

liquid is out of contact with the zinc and carbon, so that to excite it, it is only necessary to turn it upside down. The exploring probe, Fig. 3, is a rigid or flexible canula, designed for making a preliminary examination of the wound, and for facilitating the introduction of other apparatus. The revealing device, Fig. 2, is a small glass-enclosed electro-magnet, which communicates with the battery and also with a needle which vibrates above a dial as shown. Also attached to the electro-

FIG. 2.

magnet are two isolated wires contained in a single protecting tube. The ends of these wires protrude slightly beyond their envelope, and when they touch a conducting substance, the current is established through the electro-magnet, and the needle is caused to oscillate.

In examining a wound, the first operation is to insert the canula, Fig. 3, in which a solid mandrel is inserted. By this

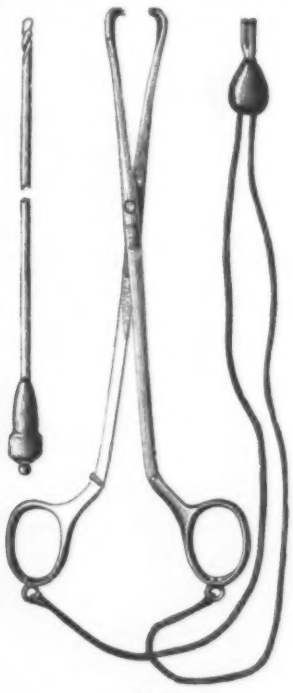


FIG. 3.

means alone the presence of the solid body can be often recognized; but in many instances the projectile becomes enveloped in the tissues or in a morsel of fabric carried in with it. This being the case, the solid mandrel is withdrawn and the canula only left in the wound. The rod of the revealer, Fig. 2, is then inserted, and the sharp points of the wires easily penetrating the envelope around the foreign object, the electric current is at once completed. The needle in the case then vibrates rapidly, with sufficient force to be felt by the hand.

The next question is to determine the material of which the object is composed. The establishment of the current, of course, announces a metal—and on the battle-field it may be assumed that the material is either lead, iron, or copper. Lead can easily be recognized by inclining the rod in various directions while pushed against the obstacle. The metal being soft, the points will always touch it, and the current will be uninterrupted. With iron or copper only, one point will remain in contact, and the current will be broken. To distinguish between iron and copper, a small magnetized needle is brought near the wound. The needle will be attracted by iron or steel, while to copper or bronze it will remain indifferent.

Should, however, the revealer, when its rod touches the obstacle, not indicate the passage of a current, then it may be assumed that the foreign object is some non-conducting body. As it is still desirable to know the nature of the material before extracting, M. Trouvé has devised a gimlet-pointed probe (Fig. 3), which is pushed down the canula, screwed into the object and withdrawn, when the fragments on its extremity show the substance. In case no fragments are brought out, it may be concluded that the object is silex.

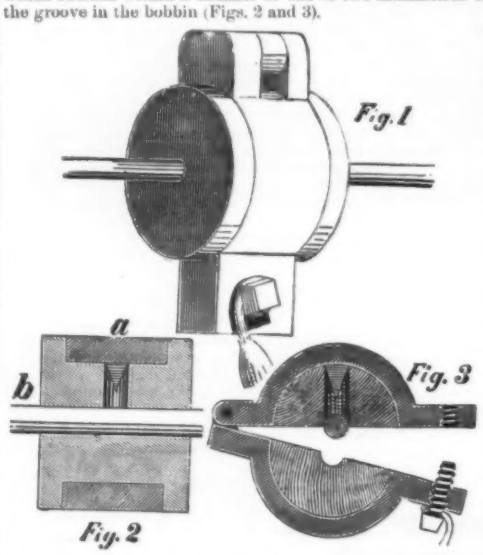
Very frequently the screw probe answers as an extractor, any removes the obstacle after the fashion of a corkscrew. The extractor adapted to all circumstances is also exhibited in Fig. 4. It is a pair of toothed pincers, the arms of which are isolated, and wires are led therefrom to the revealer. With this arrangement, when metals are to be removed, the surgeon is sure of not grasping a bone or even a portion of the tissues, since in either case no current would be established.

The Faculty of Medicine of Paris has highly commended these inventions, and awarded the inventor an important prize.

TELEGRAPH LIGHTNING PROTECTOR.

By J. E. VAES.

A RING of metal (Fig. 1) about 1½ centimetres wide, and 2½ centimetres in diameter, is cut in two. On one side the two halves are held together by means of a hinge, and on the other side they shut by means of a screw. This ring encircles a bobbin of hard wood, also cut in halves, and bored through its axis. The raised edges of this bobbin prevent the metal ring slipping off. In the interior of the ring is fixed a protecting point of aluminium, bronze, or platinum, which extends within a distance of one or two millimetres of the groove in the bobbin (Figs. 2 and 3).



To apply the protector to a telegraph wire, the ring, and with it the two halves of the bobbin (Fig. 3), are opened and placed on a wire of the same gauge as the groove in the wood. The ring and the bobbin are then closed with the screw, care being taken to pass under the head of the screw a copper wire covered with gutta percha, the other extremity of which is connected with a plate of metal attached to the bottom of the post, and making a good earth connection.

The lightning protector following all the vibrations of the wire, it is impossible that there can be a contact between the wire and the protecting point, and the point itself is excluded from atmospheric influences.

REMARKS.

1. The diameter of the groove in the bobbin should be slightly smaller than that of the wire to which it is intended to be fixed.

2. To fill up the chinks that will always exist to a greater or less extent between the two halves of the bobbin, it is sufficient to introduce, before fixing to the wire, a thin layer of gutta percha or tarred cloth. These substances, giving way to the pressure, fill up the chink entirely.

3. In case of rain, the lightning protector might give rise to derived circuits, owing to the short distance between the exterior of the metallic ring *a*, and the wire *b* (Fig. 2). Several methods suggest themselves to remedy this defect. It would be insufficient to apply a coat of varnish to the metallic parts; it would therefore be better to lengthen the bobbin so as to increase its length on either side of the ring, or even to heighten the edges of the bobbin.

Another method consists in covering the wire with an insulating material for a distance of some centimetres on each side of the protector. That which appears the simplest, and at the same time the most effective plan, is to surround the lightning protector with a covering, thus removing it from the influences of rain. Owing to its small dimensions (the protector can easily be covered with the hand), the application of this last suggestion would not be difficult.

4. It is unnecessary to say that whilst retaining all the principles on which the construction of the protector is based, it can be varied in different ways—as for instance, by replacing the protecting point by several points, or by a small plate of metal provided with teeth, etc.

5. This protector can be applied without making any special alterations to the posts. One is not limited in choice of position, and the lightning can thus be given the possibility of expending itself at a convenient distance from instruments and cables, which will find themselves in case of storms much less exposed to derived circuits.—*The Telegraphic Journal.*

LIGHTING GAS BY ELECTRICITY.

THE French Assembly Chamber at Versailles is illuminated by 356 gas burners, to ignite which, M. Gaiffe has devised the very simple arrangement represented in the annexed engraving. Two isolated bent iron rods terminate in platinum points, the ends of which are separated by about .0005 inch, and are placed exactly in that portion of the flame which is in contact with the air. All the igniters of the same group of burners are connected together so as to form a circuit. Iron is

LIGHTING GAS BY ELECTRICITY.

used for the connecting rods on account of its relatively-low conductibility of heat, and the platinum ends are placed as stated, so that the air current drawn into the flame will tend to cool them. The illumination is accomplished by merely establishing the necessary electric connection, and in fourteen seconds every gas-burner in the large hall is ignited. Substantially the same method of lighting is employed at the Capitol in Washington, and in the principal theatres and public buildings of New-York.

THE RHE-ELECTROMETER.

PROFESSOR MELSENS, of Brussels, has recently constructed an instrument which he terms the rhe-electrometer, based on the principle of the apparatus of similar name devised by Marianini. It is composed, as shown in the annexed engravings, extracted from the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, of a small compass needle, under the dial of which is placed a helix of fine metal wire insulated and wound about a hollow core of ebonite. The axis of the helix is perpendicular to the direction of the magnetic meridian indi-

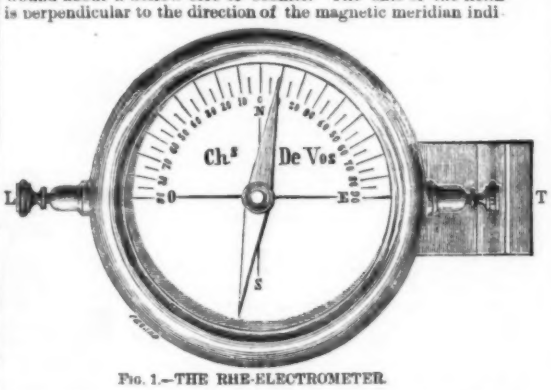


FIG. 1.—THE RHE-ELECTROMETER.

cated by the needle. One of the ends of the wire communicates at L, Fig. 1, with a telegraph-wire; the other extremity at T is attached to a ground line. An ordinary iron wire well annealed, and having no magnetic polarity, is placed inside the helix. As long as the coil is not traversed by a current, the interior wire is without influence on the needle, which remains at the zero-point of the dial. As soon, however, as a current passes, it converts the wire into a magnet, which, according to

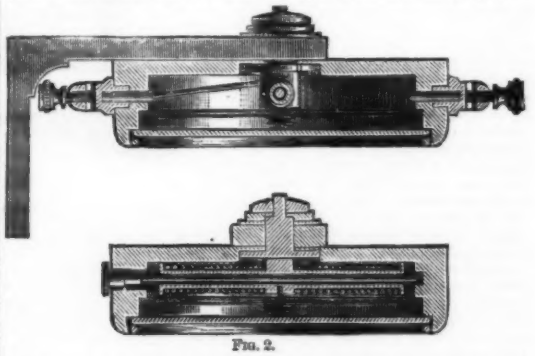


FIG. 2.

the direction of the current, attracts the needle in one or the other direction. The needle remains as deviated, and thus preserves the trace of any fugitive electric action which may affect it. Consequently, by observing the instrument from time to time, the fact of its having been traversed by a current is seen, and also, in a measure, the intensity of the current is indicated. It suffices to remove the interior magnetized wire, and to replace it with a new annealed wire, to cause the needle to return to the zero point, and to render it ready for another observation.

M. Melsens suggests that, as a telegraphic network now encompasses the globe, an extended series of observations at all telegraphic stations, by means of this instrument, would throw much light on important points relating to all electric phenomena which take place in clouds, in buildings, and on the earth. The apparatus has already been placed in several Belgian stations, in order to indicate during stormy weather whether an atmospheric discharge has traversed the lines near the different ports. The results of observations are to be immediately transmitted to the central office, so that the travel of electric manifestations in air or earth may be traced. It is hoped that laws may be thus discovered for phenomena now little understood. M. Melsens states that thus far, though he has not all the official data of observations, he has found that at each storm the instrument registers sometimes a numerous series of instantaneous currents, and that the positive and negative conditions of the line and ground wires are recognized. In one observation made at Bruges between 3.45 and 7.55 p.m., the needle has been seen to pass from ten to twelve times from East to West, and this without any change being made of the interior bar. This indicates discharges of sufficient violence to reverse the poles.

The interior construction of the device, which, it would seem, may be of important service in meteorological observations, is easily understood from the sections, Fig. 2. The cost to make the instrument in quantities of about a hundred is, in Belgium, two dollars each.

THE COMSTOCK LODE.

By JOHN S. HITTELL, of San Francisco.

PERMIT me to call the attention of the mining community to the important question of the distribution of the valuable minerals in lodes bearing gold and silver. To illustrate my ideas I have prepared the illustration given herewith from a diagram on Parkinson's map of the Comstock lode, showing a vertical section of the lode, drawn on a scale of 1200 feet to one inch. The proportions may not be observed accurately, but precision is not necessary for my purpose. The top line represents the elevation of the ground on the line where the lode comes to the surface. The bottom line is about 2400 feet below the surface, and the marks on it are intended to indicate the limits of the separate mining properties, which, beginning at the north, appear in the following order as numbered on the diagram:

Mines.	Length in feet.
1. Ophir	675
2. California	600
3. Consolidated Virginia	710
4. Best & Belcher	536
5. Gould & Curry	617
6. Savage	771
7. Hale & Norcross	400
8. Chollar Potosi	1400
9. Bullion	943
10. Exchequer	400
11. Alpha	306
12. Imperial Empire	685
13. Yellow Jacket	957
14. Kentuck	93
15. Crown Point	541
16. Belcher	1008

The white lines running down are the shafts and inclines by which the veins have been opened. The lighter spots in the vein indicate the places where the rich ore has been found; the darker streaks, including the light spots, are what I regard as the pay chutes, that is, the only places where large bodies of ore will probably be found; and the black portions are the barren chutes in which there is little probability of finding ore. This theory of pay chutes, the origin of which is unknown to me, was thus referred to in an editorial published several months ago:

1. The veinstone of every rich auriferous or argentiferous fissure lode is partly gangue, or barren rock, partly pay ore.
2. The pay ore is not scattered about in the lode without system.
3. The use by miners of the terms "pay chute" and "pay chimneys" is not accidental or unmeaning, but is the result of long experience.
4. The French word "chute," meaning literally a "fall" or steep channel, is the equivalent of chimney, and the two words are suggested by the fact that after the rich ore has been taken the hollow place is like the flue of a chimney.
5. A pay chute is a streak in the lode running down usually at an angle of not less than 30 deg. to the horizon.
6. There may be, and there usually is, much barren rock in a pay chute, but there is no large body of rich ore outside of it in a fissure lode.
7. A rich lode that has been well explored for more than half a mile usually shows more than one pay chute.
8. The pay chutes in the same lode dip in the same direction, and at the same angle, and are approximately of equal size.
9. If the sides of the lode show streaks or scratches, as if the veinstone had been pushed upward between the walls, those scratches indicate the direction of the pay chutes.
10. There are pay chutes in pocket lodes as well as in milling lodes. A pocket lode is one in which the gold is found in small clusters, so rich that much of it may be separated from its quartz in a hand mortar; whereas milling lodes are those in which the metal is scattered evenly through a large mass of rock, and can not be extracted profitably without a mill.
11. Some of the "pocket miners" in the pocket-mining districts, such as Bald Mountain, Tuolumne County, and West Point, Calaveras County, when they find a rich pocket near the surface, if they think it worth their trouble to sink, examine the scratches and run their incline down with them, as a guide for the direction in which they may hope to find another pocket.
12. The wider and richer the lode, the longer horizontally are the pay chutes as a general rule. The main measure of the size of a pay chute is its horizontal length. All pay chutes in fissure loads run down to a depth beyond the reach of practical working.
13. The chief business of the gold and silver miner is to find and follow pay chutes.
14. The money spent in exploring lodes outside of the pay chutes gives no return.
15. Many millions have been so spent in the Comstock lode.
16. All the dividends of the Comstock lode have been paid by three pay chutes, each nearly half a mile long horizontally, with barren intervals of a third of a mile between them horizontally, and half a mile vertically.
17. One of these pay chutes has produced $50,000,000, one $80,000,000, and the third may be set down with past production and ore in sight for at least $350,000,000.
18. Each pay chute has mineral or chemical peculiarities distinguishing its ores.

Although we have repeatedly mentioned this theory of pay chutes in the *Alta*, and called public attention to it, yet it has been passed over as if there were no facts to support it, and mining superintendents and engineers generally seem to attach no importance to it; and they make their plans, run their shafts, tunnels and drifts, and spend their money as if there were as much probability of finding ore in one part of the vein as in another, even after the situation and direction of pay chimneys have been well determined.

In the second annual report of the Commissioner of Mining Statistics for the year 1867 (submitted to the Secretary of the Treasury in March, 1868), mention is made of pay chimneys in the following gold mines in California—namely, the Pine Tree, Coward, Marble Spring, Goodwin and Mary Harrison, in Mariposa County; the App, Soulsby, Platt, Mt. Vernon, Sophia and Draper, in Tuolumne; the Bovee, Woodhouse and Crispin, in Calaveras; the Hayward, Oneida, Lincoln, Tellurium and Crafts, in Amador; the Pacific, in El Dorado; the Banner, in Nevada; the Sierra Buttes and Independence, in Sierra, and the Crescent, in Plumas County; and of these mines one is represented to have seven pay chutes; two, each six; two, each five; and the 23 mines together have 54 pay chutes. Reference is not made to that report as proof, for it was based on a hasty reconnoissance, but it indicates where evidence can be obtained either to establish or overthrow our theory, and we suggest to mining engineers and superintendents, miners and mine owners, the importance of making careful vertical diagrams of their workings, showing the position of their pay ore. Such diagrams would doubtless be published without charge by the *Mining and Scientific Press*, and a collection of them would, we are satisfied, be of great service to educate the mining community.

As the finding of ore is the chief talk of our mining industry, I think that you will agree with me that this theory of pay chutes deserves more attention than it has yet received, and that it is very desirable to have diagrams showing the distribution of the ore in all our valuable mines. I am convinced that our miners and mining engineers have much valuable information relating to pay chutes never heretofore published. Can it not be drawn out?—*Mining and Scientific Press.*

SECTION OF THE COMSTOCK LODE, NEVADA.

VORTEX ATOMS.

THE book which has just been published by Prof. P. G. Tait, of the University of Edinburgh, entitled, "Lectures on some Recent Advances in Physical Science," will be welcomed by all interested in this department of research as a vivid presentation of the actual position and tendencies of physical science, and of the processes by which its rapid advances in the last few years have been made. It contains the reports of thirteen lectures delivered by him in 1874, at the desire of a number of his friends, chiefly professional men, with only such changes as were necessary to adapt them to this mode of publication. The leading topics, though few in number, and expressed by titles, some of which would have been scarcely intelligible a few years since, include the chief phenomena of matter and force. Starting with the history of the modern doctrine of energy, he goes on to the principle of the transformation of energy, which finds its application in such manifold ways, to the phenomena of light, heat, and electricity, to the movement of gaseous molecules, and to many other subjects which need not be enumerated here. In the later lectures he considers some of the hypotheses by which physicists are boldly pushing out into the almost unknown regions of the ultimate structure of matter, and the modes of action of the different forms of force. Of these one of the most interesting is Sir W. Thomson's brilliant suggestion of vortex-atoms, a theory which, though surrounded with most formidable mathematical difficulties, has already, in the hands of its author and by the investigations of Prof. Helmholz, yielded results of the highest significance. Analysis has succeeded in showing that these vortex-atoms, which are constituted like the smoke-rings thrown out from a locomotive chimney, if produced in a frictionless fluid, would move forever without loss of energy or change of form; that two such rings brought into collision are not commingled, but fly apart after the shock like perfectly elastic bodies; that furthermore, as has been shown by Helmholz, they are indivisible, and could not be severed by the keenest edge, thus literally answering to the definition of atoms. Incomplete as it is, the theory offers a probable explanation of many of the properties of matter, and appears capable of furnishing, when more fully developed, the solution of many questions which molecular science has hitherto been unable to answer. The concluding chapter further discusses some of the methods by which things so far beyond the reach of direct observation as the size of the ultimate molecules of matter, their number in a defined space, and the velocities with which they move, may be inferred with a good degree of certainty, leading to some of the most interesting results that have been attained in modern times.—*International Review.*

BUNGE'S CHEMICAL BALANCE.

ONE of the principal features of this balance is its short beam, which is of the form of a right-angled triangle. The portions which represent the sides of the triangle act as trusses to the main portion of the beam, which represents the triangle's base; this construction, together with the tough material employed for the trusses—namely, aluminium bronze, combines great rigidity with the least possible weight; it is capable of carrying a heavy load without appreciable flexure. The knife edges and bearings are of rock crystal. The edges touch the planes on a very long line, by which means great durability is obtained, and an adjustment is provided which precludes any deviation from perfect parallelism of the knife-edges, and which is a means of obtaining maximum sensitiveness. For weighing by means of riders a divided scale, attached to the beam, is projected in front so as to be easily seen, and to permit of the placing of riders on any division of the divided scale by means of one sliding arm, which works from the right-hand side, and takes the whole range of the beam from one end to the other; this arm lifts off the riders vertically, and its action is facilitated by a counterpoise, which carries it out of the way of the beam when it is let go. The mechanism for putting the beam in and out of action is efficient: By turning a crank-handle (on the left of the base) with a forward movement, the supports under the pans are lowered, and by limited reversal of the movement of the handle, the pans can be quieted without otherwise interfering with the balance; on turning the crank further forward, in continuance of the initial movement, a bearing, on which the pans hang when out of action, is lowered, and in its descent places the pan-suspensions upon the terminal knife edges of the beam; a still further movement of the crank puts the balance in complete action by raising the central axial bearing.

QUINIA SUBCUTANEOUSLY IN SUNSTROKE.

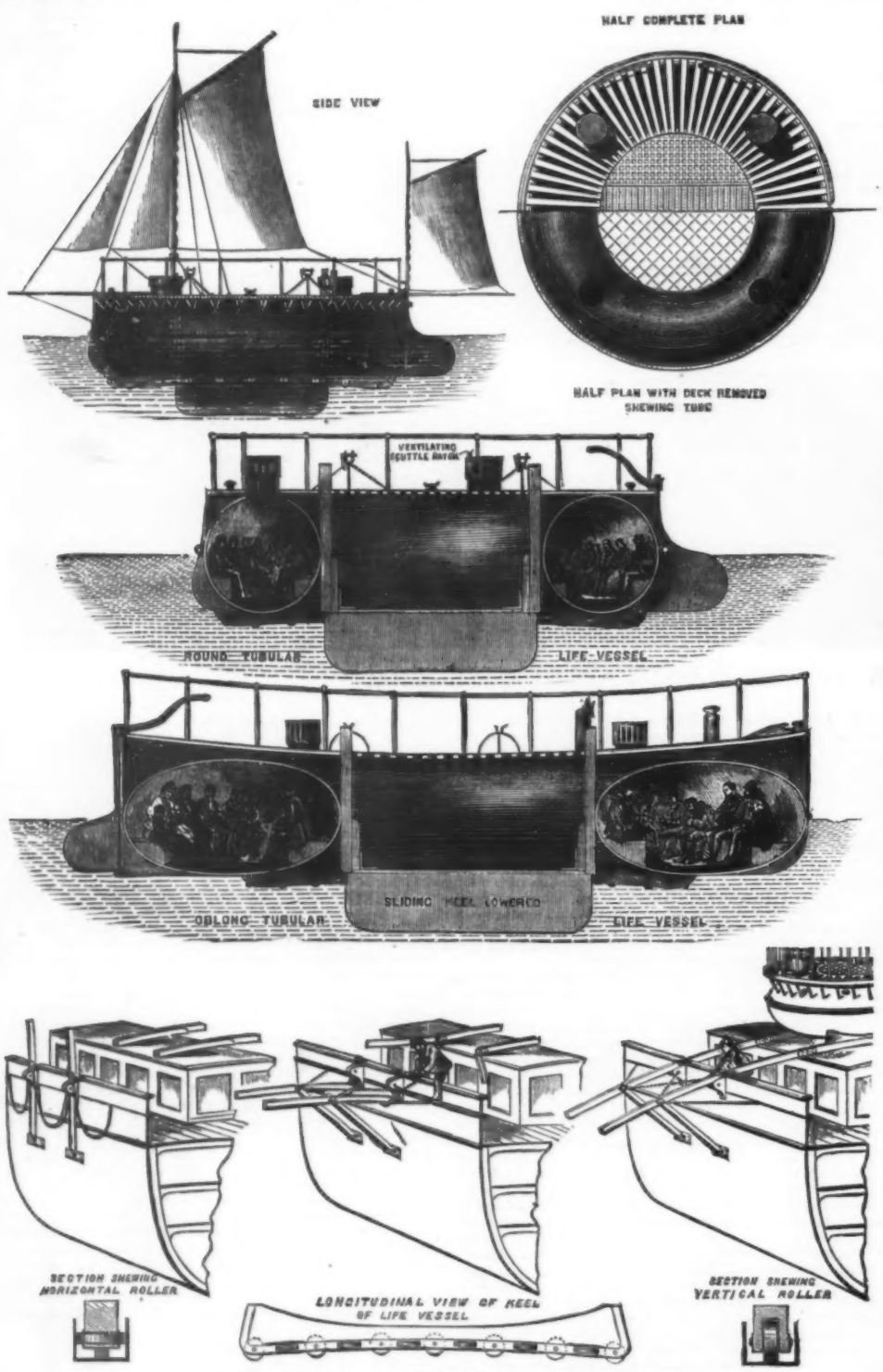
MR. A. R. HALL, of the British Army Medical Department says that the experience of several medical officers in India is now apparently sufficient to prove that the hypodermic injection of quinia in heat-apoplexy is the most successful mode of treatment that has yet been adopted. In May, 1869, Mr. Walter Kerr, of Calcutta, told him that he had been very successful in treating sunstroke by doses of twenty to thirty grains of quinia given by the stomach, and advised him to try it. A short time afterwards Mr. Hall did so in the case of a driver who was attacked about half-past five in the afternoon; and who, when seen, was completely comatose, with dilated pupils, stertorous breathing, face very much flushed, skin red and burning hot, pulse full and rapid. Twenty grains of quinia were dissolved in twenty minims of dilute sulphuric acid and about three ounces of water, and the attempt was made to get the patient to swallow it, but failed. A solution of five grains of quinia, in five minims of dilute sulphuric acid and fifty minims of water, was then injected under the skin in different places about the shoulders. Within one hour the heat of the surface had perceptibly increased; he steadily improved during the night, was quite sensible next morning, and recovered without any bad symptoms. Surgeon J. Anderson shortly afterwards, in the same hospital, treated a case with equally satisfactory results. Mr. Hall attended five cases of heat-apoplexy and employed this method, and all recovered.

WALNUT LEAVES IN MILIARY TUBERCLE.

DR. A LUTON, of Reims, advocates in the *Bulletin Gén. de Thérap.* the use of the extract of walnut leaves in the treatment of the condition known as granular tubercle; and, like many French writers, becomes very enthusiastic in its praise, although his observations are not based upon any considerable number of cases. He administers the extract in doses of one, three, and five grammes in a mucilaginous mixture, to be taken in tablespoonfuls every hour. Dr. Luton has also employed a tincture made from fresh leaves, in the proportions of 1 to 1, the dose of which is from five to twenty-five grammes, but has had most experience with the extract. The effects of the remedy are said to be appreciable on the first day in the lowering of the fever, clearing of the tongue, improvement of appetite, and increased activity of the functions in general. The dyspnœa, when the disease is located in the lungs, is less troublesome, the pneumonic engorgements disappear, the râles become moist and expectoration easier, etc. In cerebral tuberculosis, Dr. Luton has less hope of favorable results, owing, mainly, to the lateness with which therapeutical measures are commonly resorted to. When there is a disposition to vomit, the medicine can be given by enema.

NOVEL LIFE-BOAT.

SEEING the necessity of some better means for saving life than now exists on any of our passenger vessels, Mr. Stockwell has devised a plan by which he proposes to carry in safety, out of the way of the crew and passengers on deck, a life-saving vessel, always ready to be launched—and that easily done—which, when in the water, is a self-contained ship, non-capsizable, sufficiently large to carry all on board, complete with provisions for a long voyage, and provided with masts and sails, a keel and rudder, so that she may be navigated until a port is reached. This vessel is built either in the form of a cylindrical ring or of an elongated tube, the former being shown in our illustration, in which the deck has been removed from the lower half of the plan in order to show the tube. This form of construction insures immunity from capsizing, as the sea breaks up through the central portion, which is only covered by a grating. The interior of the tube forms the cabin for the crew, and is reached by means of


SIDE VIEW
HALF COMPLETE PLAN
HALF PLAN WITH DECK REMOVED SHEWING TUBE
VENTILATING SCUTTLE HATCH
ROUND TUBULAR LIFE-VESSEL
OBLONG TUBULAR LIFE VESSEL
SLIDING KEEL LOWERED
SECTION SHEWING HORIZONTAL ROLLER
LONGITUDINAL VIEW OF KEEL OF LIFE VESSEL
SECTION SHEWING VERTICAL ROLLER

STOCKWELL'S IMPROVED LIFE-BOAT.

hatchways in the deck. It is fitted up with seats, as shown in our engraving, under which are bunkers for provisions and water, which are intended always to be kept ready for an emergency. Ventilation is effected by means of ventilating caps, which admit air, but keep out the wash of the sea. The whole tube is divided into four compartments, by water tight bulkheads, which are provided with dead lights to give light to the interior. A light batten deck is fitted on top of the vessel, and stanchions and guard rails are provided to prevent the crew from being washed overboard. Each one of these vessels is provided with masts, sails, rudder, false stern, and adjustable centre-board, or sliding keel, as shown. They also carry a binnacle, signal lights, and rockets, and a fair speed is attainable, and a moderately good course can be held. Fenders are provided round the vessel, and life lines are attached at various points, carrying cork balls at their ends to denote their position. The seaworthiness of one of these vessels was thoroughly tested in very rough weather, for she was out in Sea Reach in the memorable storm when the screw steamship Deutschland struck on the Kentish Knock, on which occasion she behaved remarkably well, and the crew being housed comfortably below, the high sea did not affect them in the least, for the aperture in the centre of the vessel appears completely to have destroyed the force of the waves. The men had a small cooking apparatus on board, and enjoyed the novelty of their position immensely, being only sorry afterwards to find that, though close to the ill-fated Deutschland, they had not been able to save some of those on board her, from ignorance of the disaster. During the autumn the life vessel was afterwards tried on various parts of the coast, in all cases with complete success; for, as an official who came off to her in his lifeboat from Garrison Point, near Queenborough, remarked to the captain, "She might starve them, but never drown them;" and indeed, before the close of her cruise it was most satisfactorily proved that by these life-vessels persons at sea can be saved in cases of fire or shipwreck, it being possible to carry food and water for a long voyage, and to make a port in due course.

The efficiency of the vessel itself having been thus satisfactorily proved, it is necessary to describe the mode of launching from the deck, for it is no small point that this should be both simple and efficacious. The method is shown in three views. The life-vessel is carried on skids above the deck in the same way as ships' boats are usually carried, generally on the top of a deckhouse. The skids are made of groove-shaped iron, and are carried out beyond the side of the vessel by means of continuation pieces, hinged at their upper ends, and held in position for launching by resting on the bulwark, where they join other pieces, hinged on struts to the vessel's side, so that they can be easily stowed out of the way against the side of the ship, or put in position for launching. To the life-vessel keels are attached, in which both horizontal and vertical rollers are fitted to prevent friction and jamming in the groove ways, the skids and launch ways being always of a curved form. By the withdrawal of a pin the vessel runs rapidly down the curve with a speed that sends her well clear of a sinking ship. In troop and emigrant ships the life-vessels would be made very large, and then it would be preferable to carry them on the deck itself, the bulwarks being hinged to fall down in wake of them in case of need, for they could then be utilized as deck houses or look-out bridges. In the case of a ship sinking bodily, as the life vessel rests only on the skids, she would float off in safety. The same vessel which made such a successful tour of the coasts was launched in November, 1875, at Blackwall Point, off a deckhouse 9 feet 6 inches above the main deck of the hulk Ocean, which was 10 feet 6 inches above the water, the life vessel being thus launched from a height of some 20 feet above the water—a height much in excess of what would be required in ordinary cases. The vessel, however, went off quite successfully from this great height, although at one time she was completely clear of the ways before she touched the water, which entirely proved that there was no fear of her capsizing under any circumstances.

We must confess that we think, all things considered, Mr. Stockwell has done more than any one before him to solve the problem of a life-saving vessel answering the many requirements of such a vessel, to be carried on board ship. It has been said that we should seek rather to strengthen our ships and to render them seaworthy, than to devise means of leaving them; but, unfortunately, fire is an element which attacks us often at sea when we least expect it, and it is, too, a most difficult enemy to cope with, from whom, indeed, it is sometimes absolutely necessary to run away; and in such a case, the loss of life which attended the burning of the Cospatrick showed how necessary it was to have some other safeguard than ships' boats to trust to in such an emergency. The ocean, too, is studded with rocks, and though these are theoretically known, and should, therefore, be avoided by every captain, every human being is liable to error; and, as we have often seen, captains of merchant vessels are but human after all, and are, therefore, liable to put their ships upon a rock, and when once in such a position, the best design and construction in the world will not always save them from destruction and their crews from drowning, unless they are provided with some trustworthy means of escape.—*The Engineer.*

THE NEW PORTAGE BRIDGE.

THE Americans are *par excellence* a race of bridge-builders. Within the last quarter of a century bridges and viaducts have been erected that vie with the Roman aqueducts in the magnificence of their conception, while they excel them in the science and daring of their construction. The new Portage Bridge is another addition to the number of structures which place our American cousins in the van of the age for their skill in what we may term the "scientific elegance" of the structural art. The old and famous timber viaduct over the Genesee river, on the Buffalo division of the Erie Railway, was totally destroyed by fire on May 6th of last year, and before daybreak what had been considered a marvel of timber construction was a mass of ashes. This viaduct was 850 feet long, of 50 feet spans, and of the immense height of 234 feet, the piers or trestles being each of three bents, resting on stone bases. A new iron bridge was at once decided upon, the designs of Mr. George S. Morison, C.E., were prepared immediately, and the contract for ironwork was let to the Watson Manufacturing Company, of Paterson. A paper on the structure, read by the author at the American Society of Civil Engineers, furnishes some interesting details. The piers and abutments were rebuilt, and in the repairs to the masonry of some of the piers extensive use was made of French béton (Coignet's), in which those portions were encased which were exposed to the action of frost and water. In general design the new structure partakes of that web-like character which distinguishes the structures of the American engineers. For this general characteristic of the design we can not altogether blame the engineer. In this case the circumstances of the company required the least outlay, and a single-track structure that could be easily altered for a second track was designed. The supporting columns are designed for a double track; but the trusses—20 feet from centre to centre—were calculated only for a single track. The increased strength demanded by the future addition can be attained by inserting similar trusses close to those already fixed. The viaduct is of ten spans of 50 feet each—two of them being 100 feet, and one of 118 feet. A 50-foot span is placed between each of the longer. There are six supporting trestles or skeleton towers of varying height, from 203 feet—exclusive of stone cutwater piers—to 50 feet at the abutment ends. [See engraving, page 60 of SUPPLEMENT.]

While we can admire the mechanical dexterity evidenced, and the economical distribution of the material, we should have preferred the design if the trusses had been of bow-string shape, and a little less of the *tour de force* character had dominated. But the work shows what is possible in iron. The total cost of the iron structure was $95,000, and displays, as the author says, the low price of iron and the economy of iron skeleton structures in America.—*The Building News.*

FORMATION OF CRYSTALS.

AT the first meeting of the Section of Physical Geography, Geology, Mining, and Meteorology, lately held in the Conference Room of the Loan Collection at South Kensington, Professor Daubrée delivered in French a lecture on the part which experiment should play in geology, remarking that observation had been too exclusively employed. He gave an account of experiments of his own, in which, in order to reproduce geological results by the causes which may have led to them, he enclosed water in glass tubes, the glass tubes in water again, this water in strong iron tubes, and subjected the whole to great heat. The result of the pressure and heat was in many cases to produce fracture of the outer tubes and failure of the experiments. In other cases, however, the silica was forced from the glass, and there were formed of it quartz crystals not distinguishable from those met with in nature. A second class of experiments was that made for us by the Romans. They, at Plombières and elsewhere, widened the opening of hot springs and lined it with masonry. In the known numbers of years which have since elapsed the bricks have undergone changes and crystallizations which are instructive.

THE CHANNEL TUNNEL.

THE preliminary works in connection with the Channel Tunnel have been lately commenced at Sangatte, near Calais, France. The work is being carried on rapidly, the laborers working day and night. A powerful pump has been set up to absorb the water that is met with in rather large quantities. When these shafts have reached a depth of 100 metres below the sea, a gallery 1 kilometre in length will be made in the hard chalk. If this can be done successfully, and nothing occurs to show that the works are impracticable, the tunnel will be definitely commenced.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

No. 3.

THE skiff last described is complete only for rowing. To adapt it for sailing, also, it must be provided with centre-board, sail, spars, and rudder, the making of which we will now describe. The centre-board consists of two parts—the centre-board proper, and the "well" or "trunk." The trunk is a thin, bottomless case or sheath (Fig. 20), made by two boards for sides 1 inch thick, 12 inches wide, and 3 feet long, nailed strongly upon end pieces 12 inches long, 1 inch thick, and 1½ inches wide, placed between the sides at the ends, making the space between the sides 1 inch wide. Before caulking—if caulking is resorted to—cut a slit longitudinally, 3 feet long and 2 inches wide, through the middle of the bottom, with the forward end 4 feet 1 inch from the bow. This hole cuts through the long bottom board and divides several cross-bottom boards into halves. It is best, therefore, before sawing, to secure the cross-bottom boards to the long-bottom board by additional nails. The sides of the trunk are grooved on their lower edges, leaving tongues ½ inch thick (Fig. 20). The width of the part of the slit through the long bottom board is increased ¼ inch on each side; the part of the slit through the cross-bottom boards remains 2 inches wide, making a shelf. The trunk, when placed upright, slips into the wide slit, the shoulders made by the grooves in the lower edges rest on the shelves, and the tongues on the lower edges of the trunk enter the narrow slit. Nails are then driven through the shelves into the shoulders at D D, Fig. 20.

FIG. 33. A FOURTEEN-DOLLAR SAILING SKIFF COMPLETE.

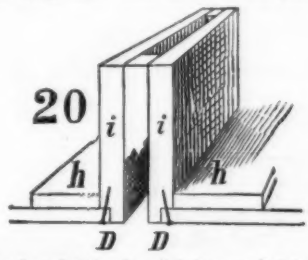
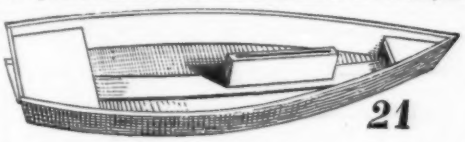
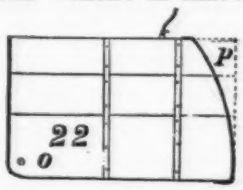


Fig. 21 shows the trunk erected in the boat. The rower's seat is placed 4 inches aft of the after-end of the trunk, and the middle point of each rowlock is 10 inches aft the after-edge of the seat.

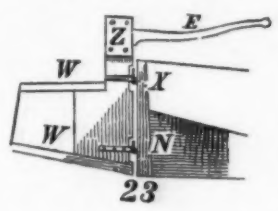


In Fig. 22 is presented the centre-board proper. It may consist of either one or two boards, but, in either case, it is either crossed by two iron bands near the ends let into one side, or it is bound on the ends by iron straps. The shape should at first be rectangular; the length, 2 feet 8 inches; the width, 14 inches; the thickness, ¾ inch. Place it in the trunk with its lower edge even with the bottom of the boat outside, and then 1½ inches above the long-bottom board and 5 inches from the forward end of the trunk; bore a ¾-inch augur hole through both sides of the trunk, and through the centre-board inside. Withdraw the centre-board, and with the hole thus made at O as a centre (Fig. 22), describe an arc at P. Saw off the end projecting beyond the arc P, and round the corner at O. Paint the centre-board, then replace it in the trunk, and lightly drive an oak peg through both trunk and centre-board in the hole already made. Drive a small staple into the upper edge of the centre-board, near the aft end (Fig. 22), into which a cord is tied to raise the centre-board.



According to the directions heretofore given, the stern-piece has a slant or "rake" of 4 inches, but to adapt the boat for a rudder, the stern-piece (Fig. 23) and the strip N should be vertical or nearly so, as the figure shows. In the previous description, too, the width of the "skag" N, same figure, is 6 inches; but, when a rudder is employed, the width of the broad end may well be increased to 8 inches.

Fig. 23 presents the rudder; N is the skag, W W are the strips that combine the two parts of the rudder. Even when the rudder consists of one piece, these strips, of iron or of wood, must be used to prevent warping. The rudder-head Z is more clearly shown on the right. The



depth of the mortise formed in the rudder-head is about 3 inches; height, 2 inches; and thickness, 1 inch. E, the tiller, is about 2 feet long. The "gudgeons" opposite X and N, if they can not be conveniently bought at a ship-chandler's, may be made by a blacksmith.

Fig. 24 gives a clearer view of one

pair. The length of the rudder is 2 feet, the entire height such that the tiller may swing free, and the height from W to W about 12 inches.

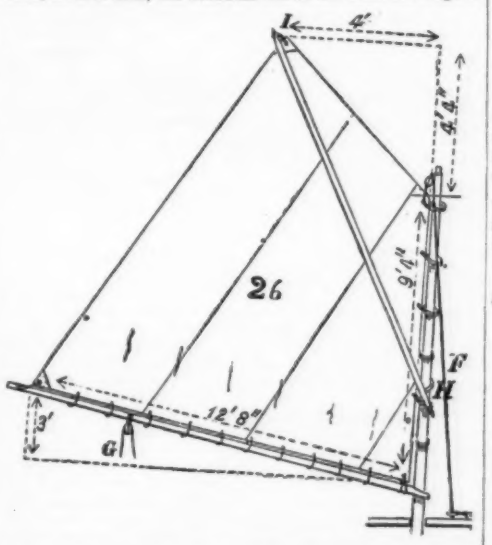
The seat board at the bow, Fig. 13, when used as a seat merely, may be ¾ inch thick and 18 inches long; but, when designed to receive a mast, it should be more securely fastened, 1 inch thick, and 22 inches long. The mast hole Y is 3 inches in diameter, its middle point is 12 inches from the extreme bow, and exactly under it a short board 1½ inches thick, 4 inches wide, and 9 inches long, containing a square socket, 2 inches square, to receive the lower end of the mast, is screwed to the long bottom board. The socket must be exactly under the hole in the seat. The mast is a straight pine pole between 2½ and 3 inches thick near the butt, 2 inches at the smaller end, and 11 feet 2 inches long. The butt is squared to fit the socket, and a staple is driven into the smaller end, to which a small block is attached. Make the boom more slender; its thickest part is about 2 inches diameter, and should occur at about half the length. Screw or bolt pieces ¾ inch thick to one end of the boom, making the

Fig. 25

"jaws" shown by Fig. 25 to fit the mast T, around which a wire hoop passes from one jaw to the other.

The "sprit" is a pole a little thinner than the boom, about 12 feet long, and sharpened like a stake at each end.

The sail can be made of coarse muslin. The widths lap about an inch, and are sewed together in two seams by the sailmaker's stitch, Fig. 31. The sail is shown by Fig. 26, in which, as it is seen, the breadths are so cut that the edge at



the mast is bias. The edges of the sail are hemmed all round, and in the hem is run a white cotton cord about ¼ inch thick. Eyelets are made in the edges at the boom and the mast, and sewed like button-holes. A row of "reefing nettles" is not necessary for small streams, but usually they are quite convenient. They are made by pieces of the ¼-inch cord, 1 foot long, passed through strong eyelets in the sail, and knotted on both sides (Fig. 32). These are about 2 feet above the boom.

The six hoops on the mast, if not bought at a ship-chandlery, can be made by bending strips of green oak, and notching the ends like barrel-hoops. They should fit quite loosely on the mast.

The ¼-inch cord already used will do to tie the sail to the hoops and to the boom.

The "becket" at H, Fig. 26, is presented in Fig. 28, where U is the mast, and V the lower end of the sprit, which rests in the loop of the becket. All the cord or rope used may be white cotton cord ¼ inch thick, as previously described. The sail is raised by the halliard F (Fig. 26), which is 19 feet long, passing through the block on the mast; the upper end of the sprit is placed in the loop attached to the sail at I, the lower end in the loop of the becket; the becket is then shifted up the mast till the sail hangs smooth, and the noose of the becket is tightened.

The "traveller" is a thin iron rod terminating at the ends in straps where it is screwed to the stern-piece R, Fig. 27. The horizontal portion of this rod is about ⅜ the width of the stern, and passes about an inch above the tiller. Sliding on the traveller is the ring Q, Fig. 27, 2 inches diameter, to which

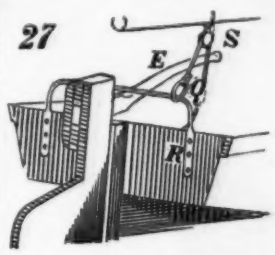
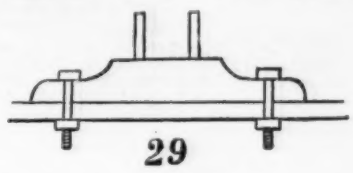


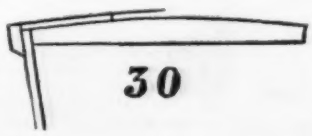
Fig. 28

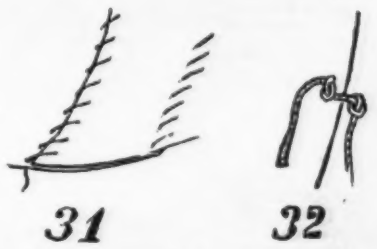
one end of the "sheet" is tied. The sheet, *i.e.* the rope which trims the sail, is then passed through the block S, on the boom, over the traveller, and thence to the boatman's hand. This sheet should be about 24 feet long.

The skiff is now complete for either sailing or rowing. The cost of materials for sail, rudder, centre-board, and every additional requisite for sailing should not exceed $9.

A deck is seldom desirable for a boat of this description, but a few hints on the subject may not be misplaced. Fig. 33 shows a skiff with a deck. The cockpit begins about 4 feet from the bow in a boat 12 feet long, leaves about 9 inches of deck room on each side, and extends to within 18 inches of the stern. The "combing" is a thin board placed on edge, and nailed to the inside edge of the deck. As represented in Fig. 33, it forms a bulwark about 2 inches high, entirely around the cockpit. The deck beams are curved (Fig. 30), 1½ inches wide at the ends, and about 2½ inches in the middle. They are ¾ inch thick, and about 18 inches apart. Where the cockpit is they are not used, as they can not extend entirely across the boat. They are nailed at the ends like the cross-piece, Fig. 13. The deck boards lap over the edges of the side boards, and are nailed to them (Fig 30), and the upper streak is nailed on afterward. The middle deck-board,







through which the mast passes, is 1 inch thick; the others, ¾ inch. Fig. 29 is the rowlock bolted to the deck, near the outer edge. A deck is useful only in rough water.

If a skiff of larger size is required, the following table will be useful. The dimensions not given below may be readily determined by increasing those already given for the smaller skiff.

Length, 16 feet; beam, 5 feet; depth, 18 inches.

Centre-board, 4 feet long, 14 inches high; forward end, 5 feet 6 inches from bow.

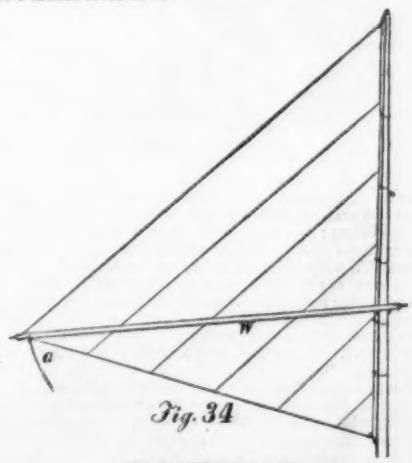


Fig. 34

"LEG O'-MUTTON" SAIL.

Rudder, 2½ feet long.

Sculls, 10 feet long.

Height of sail on mast, 12 feet 3 inches; length on boom, 17 feet.

Mast, 16 inches from bow.
1-inch cedar is used for sides, bottom, and most other parts.
The centre-board proper is ¾ inch thick.

The foregoing sail is the most effective, and quite easily made and managed; but a still simpler form is shown in Fig. 34 It is familiarly termed a "leg-o'-mutton sail." It may be merely tied to the mast, and wrapped against it when furled, or it may be attached to hoops like the foregoing, and raised by a single halliard and block. The boom W may be tapered, one end fitting into a loop in the sail and the other into a becket on the mast, or it may be rigged as in Fig. 26; the latter arrangement being much the better for sailing. A sheet block (G, Fig. 26) is not positively necessary, and with it the traveller may be abolished. The length of sail should be about 13 feet on lower edge, and 13 feet 8 inches height on mast. Length of mast, about 15 feet 9 inches.

The triangular sail is suitable for occasional or auxiliary use, or for sailing before the wind, but for "tacking" or "beating" it obtains little favor. It is regarded as a little safer than the sprit sail.

PROPAGATION OF BROOK-TROUT.

THE *salmo fontinalis*, or speckled trout, is more widely distributed than any member of the salmon family; its habitat embracing a large area of the temperate zone in both hemispheres. For delicacy of flavor, it has no equal among the finny tribe; its symmetry of form suits the eye of an artist; and its sagacity and wary habits test the skill of the most accomplished angler. There is a fascination about trout-fishing which jurists and theologians cannot resist, and with many it amounts to almost a passion. Every season hundreds of men leave their pleasant homes and families for the Adirondacks, the North Woods, or the wilds of Canada, exposing themselves to innumerable hardships, contending with mosquitoes, gnats and black-flies, in order to gratify this desire. We do not blame them, for with all its drawbacks trout-fishing undoubtedly pays. Indeed, our hard-working population need more of such pastime. Every sportsman knows that the exhilaration experienced in capturing a fine trout is more delightful than a glass of brandy, and infinitely more lasting.

We propose to show in this paper, that with the advantages of co-operation this rare sport, now monopolized by the few, may become accessible to all. To make the subject clear, we will first give a description of the habits of the trout, and show the causes which have led to the depletion of our trout-streams; and, second, explain the artificial method of propagation, and the facility it affords for re-stocking our waters with this popular fish.

Brook-trout spawn when they are eighteen months old: at this age they produce nearly two hundred eggs; the season following four hundred or five hundred; at one pound weight, one thousand; and more or less as they go over or under this weight. Fish farmers call the males milters; and the females spawners; so we will adopt the same terms.

Near the last of September the milters begin to work up-stream in search of suitable places for spawning. They select a place where there is a clear, gravelly bottom, with a gentle stream. They make a bed nearly eighteen inches in diameter, and three or four inches deep. Ten days after the spawners make their appearance each one takes possession of a nest; whether the combination is accidental or preconcerted I am unable to say. While depositing the eggs, the spawner remains near the centre of the nest, while the milter is circulating around it, occasionally darting off after other fish which generally hover about the vicinity watching for a chance to pick up any eggs that may get out of the nest.

In a week each pair finish spawning, cover their beds with small pebbles, and leave the spawn to their fate. In ordinary brook-water they will hatch in about 100 days; but during this time the eggs are a prey to all kinds of fish that can get access to them. Ducks and every variety of water-fowl are extremely fond of them. The evet, or water-lizard, will sometimes devour the contents of a nest at a single meal. But the worst enemy of the young spawn is roily water; this kills them by the wholesale. In cultivated districts, where the streams are liable to become muddy, it is estimated by careful observers that ninety per cent of the eggs perish from this cause alone. Within the past twenty years a good many experiments have been made to obviate, if possible, this great waste. The most successful method known at present is the following: The fish farmer builds at the head of his trout-pond a long, covered sluice-way, called "the spawning-box." It may be from two to eight feet wide, according to the size of the pond or volume of water entering it. The water should be six or eight inches deep at the head, and one foot or more at the lower end. The bottom of the box being covered with coarse gravel, the fish, true to their instincts, will deposit their spawn in it, as they always select a gravelly bottom. If there are no gravel beds in the pond, every fish sooner or later will find its way into this race whenever it is ready to spawn.

In the latter part of October, when the fish begin to come into the race, the operator shuts the gate at the lower end, dips the fish out with his hand-net and takes the spawn as follows: first, he takes a spawner with his right hand; grasps the fish near the head, and holds it over a pan of water; then with the thumb and fore-finger of his left hand he gently presses the sides and abdomen of the fish downward; if the spawn is ripe it flows into the pan readily. A milter is then taken, and the same operation repeated. After taking the spawn from three or four fish, the pan is set in a cool place, where it may remain for half an hour. The water in the meantime should be stirred once or twice, that the milt may come in contact with every egg; they are then put in the hatching-box. Some fish-breeders rinse the spawn in one or two waters before applying the milt. Others adopt the dry system; that is, strip the spawn and milt into separate pans without water, and apply the water afterward. It takes but a very little milt to fertilize a good many eggs. If two or three drops of this spermatic fluid is mixed in a glass of water and put under a microscope, hundreds of spermatozoa or germs of the young fish can be seen moving about in every direction. At first they are quite lively; but after fifteen or twenty minutes they gradually become motionless.

Now if we examine one of the eggs under the same condition, we notice a small aperture on one side. Curiously enough, this orifice is always on the upper side when the eggs are in the water. This shows that the opposite side of the egg is the heavier. When the milt is applied to the eggs one of these germs enters this orifice, which then partly closes, thus preventing others from entering. It sometimes happens that two enter at the same time, and the result is, two fish are hatched out connected like the Siamese twins. I noticed several pair in my hatching-boxes this spring. They are merely curiosities, as they live only for a few weeks.

During the period of incubation it is through this orifice that the embryo fish receives its oxygen, or in other words, breathes. This explains why roily water is so fatal to the life of the eggs; the eggs may be covered with sand and they will live for weeks; but the fine, almost invisible sediment does the work. It settles on the egg, stops up the aperture, and the embryo fish dies from suffocation.

HATCHING-HOUSE.

This is usually located near a spring, but care must be used in its selection. Springs issuing from clay banks or quicksands will be too roily; but those that come from rocky, gravelly, or alluvial soil are the best. The spring should be walled up in order to keep out the surface water; it is then conducted into a tank, and passes through two or three flannel strainers before it enters the hatching-boxes. These may be of any desired length, provided there is a few inches' fall once in twelve or fifteen feet, to aërate the water. The width of the box may be from twelve to eighteen inches, according to the flow of water, which should be a gentle current, but not strong enough to move the eggs. The bottom of the box is covered with gravel; on this the eggs are evenly distributed, the water being from one to two inches in depth. They will hatch in spring water at the end of fifty or sixty days; but during this time they will need feathering over once or twice a week unless the water is very clear. This operation consists in agitating the water with a feather edge of a quill, moving every egg, beginning of course at the upper end of the box. In this way the sediment will be carried off, the dead eggs will turn white, and may easily be picked out with forceps There is a vegetable parasite called byssus, which sometimes destroys a great many eggs. Its nucleus is a whitish, hairy-like substance, which attaches itself to the egg and soon envelops it; then it sends forth shoots which fasten on other eggs and cover them in like manner. In two or three days, if not disturbed, it will extend to half a dozen.

The only remedy I know is to throw out the eggs as soon as they are affected, and keep the boxes as clean as possible. It may be prevented in a good degree by painting the sides and bottom of the box with asphaltum or some water-proof varnish, and boiling the gravel before using it.

When the young fish emerge they have what is called a sack, attached to the abdomen; it is simply a part of the egg. It takes about forty days to absorb this sack, during which time they require no food. The trout intended for private ponds are kept in the hatching-boxes a few weeks longer, until they have learned to feed. Those that are going to stock public waters should be put in the head-waters, where the streams are not more than a foot wide, or beyond other fish. They will then get accustomed to the stream, and work down as soon as they are able to take care of themselves. Most fish-breeders at the present time manage to hatch about 90 per cent of all the eggs they lay down; some claim 95 per cent, or more.

With these facilities our rivers and streams might again be made to teem with brook-trout. All that is needed is co-operation. Every township should have its hatching-house, and every stream should be well stocked. This business should be kept up every year, as but little reliance can be placed in the natural process of propagation in the cultivated districts. There is not the least danger of overstocking, as the surplus will be kept down by the large fish, and they in turn by the angler. In regard to their supply of food, there is little to fear. The earth, air, and water are full of animated life. A large class of insects pass the first stage of their existence in the water. Others in their wild flights fall into the first stream they meet, and nearly all the insect tribe at some period of their life seek the water. Its sheeny surface seems to have an attraction for them which is irresistible. For a brief time they flitter and dance to the rippling waters, and then go down with the current, and probably into the throat of some fish. Trout also feed on river mollusks and crustacea. The common earth-worms also afford them a large supply of food. In cultivated districts the soil is full of them. They are nocturnal in their habits, and during wet weather work into the stream in great numbers.

Every tree and bush that hangs over the water is a breeder and harborer of insects, and every breeze showers them into the waters below. In fact, the more minutely we examine this earth of ours the more we are impressed with the vast resources which we have hardly begun to utilize. But whether it will pay to raise trout in tanks and small ponds, and fatten them for market as we do poultry, is yet an open question. If some cheap vegetable diet could be found that would take the place of meat, the question would be settled at once; provided the present price, one dollar a pound, could be relied on. But when a thorough system of stocking our public waters prevails we shall look for lower prices and larger and more uniform supplies.—*American Socialist.*

LIGHTNING CONDUCTORS.

AT one of the recent scientific conferences at South Kensington, Dr. R. J. Mann gave an account of lightning conductors, laying particular stress upon the necessity of providing a sufficient outflow for the lightning channel. He gave the arithmetical proportions which must be observed between the height of the conductor, its circumference, and the outflow; and mentioned that coke saturated with water was the best material in which to imbed the base of the conductor for the purpose of establishing sufficient earth contact. It is not necessary, he said, in answer to a question, to insulate the conductor if the proper proportions are observed. He described Sir William Snow Harris's model which is exhibited in the collection, and showed how that distinguished man, by connecting the conductors fitted to the masts with the copper sheathing of ships, established sufficient contact with the salt sea-water. Water itself, he remarked, is not an effective receptacle for electricity, but every impurity in water greatly increases its use for the purpose.

LIGHT-REGISTERING APPARATUS.

AMONGST the papers read at the conferences at South Kensington in connection with the Loan Exhibition of Scientific Apparatus was one by Professor Roscoe, F.R.S., on automatic light-registering apparatus. The object is to keep a record of the amount of light that falls at any particular spot during small fixed intervals. Clockwork drives the apparatus, photographic paper is the sensitive agent used, and by mechanical arrangements certain small portions of the paper are exposed to light action for fixed intervals, which can be regulated at pleasure. The tinted photographic paper is compared by the eye with a conventional scale of tints. No doubt a more perfect arrangement will in time be made, but even so far this has done good work.

IMPROVED GAS BURNER FOR HEATING PURPOSES.

THE accompanying engraving represents a new gas burner, designed for heating or cooking purposes, the novel feature in which is a chamber in the standard, in which the gas and air is mingled, the latter being drawn in by the ascending gas current. The object is to afford to the gas flame a more perfect supply of oxygen, and so to insure better combustion.

In the illustration, the gas is brought into the standard through the pipes indicated by the dotted lines and discharged

at the nozzle, A, into the chamber, B. The air is drawn in through the channels, C, several of which are disposed about the lower portion of the standard, and communicate with the chamber. The burner, the tube of which leads from the compartment last mentioned, is of any desired form.

For further particulars address the inventor, Mr. Anatole Ehret, No. 540 Washington street, San Francisco, Cal.

IMPROVED HORSE DETACHER.

THE object of the invention illustrated herewith is to provide a means of instantly detaching a pair or even three horses from a vehicle in case of their running away or becoming fractious. The advantages gained of course are the prevention of the injury or destruction of the vehicle, and of the greater risk of perilling the lives of passengers.

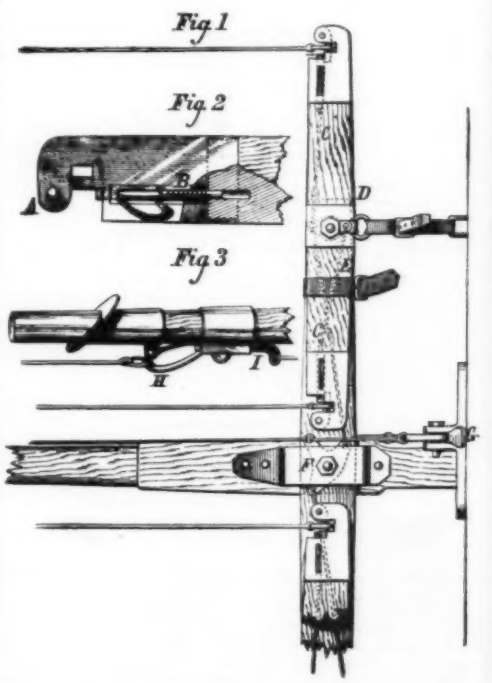


Fig. 1 shows the disconnecting arrangements located on the double tree and front portion of the wagon. Fig. 2 represents in detail the extremity of a single tree, and Fig. 3 is the end of the pole. The traces are provided with loops at their ends which slip over the hinged bolts, A, Fig. 2, at the extremities of the single trees. B is a spring catch which is held in front of said bolt, keeping the same position, and thus confining the trace. Chains, C, connect the pair of spring catches belonging to each single tree to the sway bar, D; and chains, E, connect the sway bars to two arms of a bell crank, F. The third arm of the bell crank communicates with the detaching lever, G. When this lever is pushed outward, it rotates the bell crank, which thus, by pulling on the chains, E, turns the sway bars, and the latter, through the chains, D, withdraw the catch bolts from before the trace pins, which then, swinging on their hinges, release the four trace loops simultaneously.

H, Fig. 3, is a hook pivoted, as shown, near the end of the tongue, and I is a sliding catch bolt, also operated by the detaching lever, G, through the medium of a connecting wire. This arrangement is for the purpose of detaching a third horse, which may be harnessed to the pole end.

For further information address the inventor, Mr. Anatole Ehret, No. 540 Washington street, San Francisco, Cal.

ARSENIC IN THE ARTS AS A CAUSE OF ARSENICAL POISONING.

By S. A. LATTIMORE, LL.D., Professor of Chemistry in the University of Rochester.

Delivered by request, before the Medical Association of Central New-York, at the Annual Meeting held in Rochester, May 16th, 1876.

EVERY science has its border lands, which are also the border lands of other contiguous sciences. In many cases the precise boundary lines are ill-defined—possibly indefinable. Occasionally, in the progress of knowledge and civilization, some parts of these neutral territories are themselves organized into independent provinces. For example, between the sciences of Law and Medicine lies the large territory of Medical Jurisprudence, belonging strictly to neither, yet intimately concerning both. This fact was early recognized. The Roman law referred all medical questions which arose in the course of legal proceedings to "the authority of the learned Hippocrates." The publication of the *Questiones Medico-Legales* by Paulus Bacchias, between 1621 and 1656, was the full inauguration of this new and still enlarging domain of scientific knowledge. Just two centuries later, an important part of this great field was recognized as the distinct department of *Chemical Jurisprudence or Toxicology*, when Orfila, in 1813-15, published the first edition of his *Traité des Poisons, ou Toxicologie Générale*. Within the last half century toxicology, responding to the severe demands of the various tribunals of justice, has laid all kindred sciences under tribute, pressing into its service all their most refined methods of research, until it now, with the keen tests of chemistry, the microscope and the spectroscope, pursues the criminal as a fleet and unerring Nemesis.

The department of chemical technology has furnished to the medical practitioner important aid in unfolding to him causes affecting life and health among the noxious materials and processes employed in the industrial arts.

Moreover, it is precisely along these lines of unoccupied territory that just now the medical profession chiefly,—nay, almost exclusively, by its own uncompensated efforts, is raising the new domain of preventive Medicine or Sanitary Science to a position of commanding eminence. Its comprehensive beneficence embraces the humblest and the lowliest. It not only proposes to show every man that he is, in a new sense his brother's keeper, but it also proposes to compel him, if necessary, to do that duty.

It is only on this border land between the science of medicine, represented here to-day by so many learned and distinguished men, and the science of chemistry that I could venture to meet you in response to the courteous invitation of your President.

The earliest investigations concerning the chemical properties of arsenic date from the former part of the last century. Previous to this time, it is true, some of its compounds had been known as a fearful poison sometimes employed for criminal purposes. In matters of state and of love its potent aid was not infrequently invoked. Estates and even thrones occasionally became suddenly and conveniently vacant for some expectant and unscrupulous heir. In Southern Europe, during the sixteenth and seventeenth centuries, secret poisoning became so common that the popular alarm arose almost to a panic. The famous *Aqua Tofana*, doubtless a compound of arsenic, since it was a limpid and tasteless fluid, became a fearful instrument of destruction in the hands of the celebrated demon, Tofana of Palermo, from whom it derived its name, and who, when put to the rack, confessed to having poisoned no less than six hundred persons.

After the execution of Tofana it is said an organized society was discovered in Rome whose object was the removal by poison of persons obnoxious to its members. The fortune teller often added to her profession that of secret poisoner. She might confidently predict the early death of a person who stood in the way of her client, since the means of insuring the fulfilment of her prophecy were in her own hands. It was believed that the art of poisoning had reached such a degree of refinement that the death of the victim might be fixed at any future period by simply adjusting the potency of the poison. The history of Madame Brinvilliers of Paris, who was executed just two hundred years ago, is well known. She prepared herself for her future profession in a thoroughly scientific manner by studying the effects of Aqua Tofana and of *poudre de succession* upon the unsuspecting patients in the Paris hospital. She then proceeded, *secundem artem*, to destroy her father, brothers, and many others.

Happily for society, toxicological science, by bringing to the light such secret practices, has made the existence of such monsters no longer possible.

In modern times, arsenic has passed from the hands of the assassin and become an article of widely extended use in the arts, especially those that minister to our taste for the beautiful. The quantity consumed annually is enormous, and is constantly increasing. New uses for it arise almost daily. It finds its way into every household. In view of its deleterious and often fatal effects, even in minute quantities, the freedom—rather the recklessness—with which it is placed in the hands of unsuspecting persons is highly reprehensible, and should by some efficient means be checked.

Arsenic is not an abundant element in nature, but is most widely diffused. It is especially associated with many metallic ores. It occurs in small quantity in many mineral waters, especially alkaline and ferruginous waters, such as those in the valley of Vichy, Plombières, Karlsbad and Kissingen, and to its presence has been attributed the therapeutic value of these waters. It is of common occurrence in iron pyrites, from which sulphuric acid is sometimes made; and thus this useful acid is often found arsenical to such a degree as to unfit it for certain uses. Thus, too, it passes into other products into which this acid enters, or in the preparation of which it has been employed. It has been detected even in carbonate of soda, which is obtained from common salt by means of sulphuric acid.

ARSENICAL COLORS.

Until recently the chief use of arsenic has been for the manufacture of colors. Combined with sulphur, it yields two sulphides—yellow arsenic or orpiment, and red arsenic or realgar. The splendid emerald green color produced by combining arsenic with copper, or the acetate of copper, on account of its unparalleled brilliancy, and its permanency, has won its way to popular favor, despite its poisonous character. The arsenite of copper, or Scheele's green, contains 55 per cent of white arsenic, and the aceto-arsenite, or Schweinfurt green, 58 per cent. The latter color is also known in commerce by a bewildering number of aliases, such as imperial green, emerald green, mineral green, Brunswick green, Vienna green, Vert de Montagne, &c. A painter recently told me that he did not use emerald green because it was poison, but he used in its place Vert de Montagne. He was deceived by a name.

On account of the insolubility of these arsenical pigments in any fluid which does not decompose them, they cannot be employed as dyes. Their use is therefore limited to cases where they can either be fixed upon the fabric or incorporated into its substance during the process of manufacture. They are also used both as oil and water colors.

A cake of Windsor & Newton's emerald-green water color, which I recently had occasion to analyze, contained nearly 40 per cent of arsenic—enough to kill ten people.

In the dress goods known as green tarlatan the color is emerald green, simply fixed upon the fabric with starch or size. Bright green artificial flowers are colored in the same manner. In decorative and wall papers, and cardboard, the color is spread on one side of the paper, the surface being left dull or glazed as may be desired.

In writing paper the color is mixed with the pulp and thus is incorporated into the texture. In such paper the vivid green is usually toned down by some white powder to a pale sea green.

The State Boards of Health of Massachusetts and of Michigan have, in their reports, called the special attention of the public to the great danger of poisoning from arsenical wall papers. In the latter State, samples of poisonous paper have been collected, bound into a volume, one hundred copies of which have been distributed to the principal libraries of the State, for the purpose of educating the public in some measure to protect themselves from this insidious danger.

ANILINE COLORS.

The aniline colors are obtained indirectly from coal tar, but directly from "aniline oil," by treating it with certain reagents. The majority of manufacturers prefer arsenic, notwithstanding the danger of poisoning to which the workmen are exposed and the difficulty of disposing of large volumes of poisonous residues. In some manufactures in Europe one hundred tons of arsenic are thus consumed in a single year. The beautiful color fuchsin, when made according to the French mode, is said always to contain arsenic, and since this color is the basis of nearly all other aniline colors, it is readily seen that at least a large number are liable to be poisonous. Yet we wear it in our apparel, we eat it in sweetmeats, we drink it in syrup, we write with it as ink.

MISCELLANEOUS USES OF ARSENIC.

In calico printing, of late, arseniate of alumina has been extensively substituted for albumen, and arsenic acid for the more costly tartaric acid. A crude arsenical ore, or "black arsenic," is often sold as "fly-powder" or even "cobalt," and used in the household for destroying flies. Lead shot contains arsenic, which is added to improve the spherical shape. In pyrotechny red arsenic is used in Indian fire or Bengal white fire. The transparency of glass is improved by adding a little arsenic. An arsenical soap is used by taxidermists to preserve the skins of stuffed animals. Hence you often leave a museum with a head-ache—slightly poisoned. A mixture of lime and yellow arsenic is used in dressing skins to remove the hair or wool. Shepherds use an arsenical mixture sometimes for "dipping" sheep. Yellow arsenic is used in India in preparing shellac for the market. Both the yellow and green pigments are used—less commonly than formerly—in coloring children's toys and candies. In solutions for bronzing, workmen often employ arsenic, from which they suffer greatly. Candies are often colored green or yellow by arsenical pigments, and sometimes the wicks are saturated with arsenic to improve the brilliancy of the light.

ARSENIC IN AGRICULTURE—PARIS GREEN.

In the late war with insect invaders, farmers have sought in a variety of poisons a means of protection. White arsenic has been used to a limited extent, but a wholesome fear of its deadly character has checked its popularity. The most successful competitor for popular favor has been Paris green, which is only another *alias* for the aceto-arsenite of copper, or the emerald green of the painter. If pure, Paris green should contain 58 per cent of its weight of white arsenic, but it is usually liberally diluted with sulphate of baryta. The samples which I have had occasion to analyze have contained from 11 to 27 per cent of this heavy, harmless make-weight. The quantity of this poisonous powder used in the Western States is enormous. More than a ton has been sold in a single small village in a year. Numerous instances of more or less serious poisoning by Paris green, from inhalation of the dust and from cutaneous absorption, especially where there has been abrasion of the skin, have been reported.

The familiarity of the public with the highly poisonous effects of arsenic, the facility with which it can be obtained, the ease with which it can be administered on account of its freedom from taste, have conspired to render death from arsenical poisoning more frequent than from any other poison. Consequently toxicologists have given special attention to its physiological effects and to the methods of recovery, identifying it and bringing it as a substantial witness into court to testify against the guilty. The facility with which it may be separated from all other substances, and the possibility of identifying it beyond all doubt, even in microscopic traces, are now well understood.

The compounds of this element are marked by two singular characteristics. Most arsenical compounds, excepting those of the alkalies, are insoluble, and yet they react at once, and powerfully, whenever applied to the mucous membranes or introduced into the blood. They rapidly pervade the system, soon appearing in the liver, in the renal excretions, and pervading the nervous matter and even the brain. In other cases, long after the tissues have suffered decomposition, the bones have yielded up their testimony, under the inquisition of chemistry, in the shape of absorbed arsenic.

POISONOUS EFFECTS.

While the investigation of the fatal cases belongs to the toxicologist, that of the non-fatal cases belongs to the physician. The voluminous literature of toxicology and of sanitary science abounds in clearly marked cases of chronic poisoning from arsenic, when the quantity of substance entering the system must have been infinitesimally small. Can chronic poisoning occur from the occupancy of a room whose walls are covered with arsenical paper? Multitudes of cases could be cited from the most careful and competent observers. Fatal cases even are recorded.

Dr. Taylor, in his "Treatise on Poisons"—an authority of the highest rank—speaks thus on this important subject: "The symptoms produced by arsenicated wall-papers are of a uniform character, showing their origin from a common cause. They are as follows: Dryness and irritation of the throat with cough, irritation of the mucous membrane of the eyes and nostrils, dry cough, shortness of breathing, languor, headache, loss of appetite, nausea, colicky pains, numbness, great prostration of strength, sleeplessness, a feverish condition, and wasting of the body. These symptoms may not all present themselves in any one case; they are derived from the examination of numerous cases which have been referred to me. They resemble those of a severe cold. No suspicion of the real cause has been entertained until after all ordinary treatment had failed to impart relief and an analysis of the paper had been made. The connection of the symptoms with this cause appears to have been in some instances established by the fact that after the removal of the paper, especially from bedrooms, the symptoms have disappeared."

The slight manner in which the arsenical color is laid on wall-paper, as already explained, shows how easily it may be detached and go its way to mingle with the general dust of the room. Indeed the arsenic has actually been detected, by chemical means, in the dust from the furniture of rooms hung with such paper. The possibilities of small quantities of arsenic entering the system accidentally must be apparent, when we observe the extended use made of the arsenical colors. The green paper meets us everywhere—on the walls, on paper boxes, labels, cards, tickets, stationery, paper lamp-shades, from which the arsenic is often volatilized by the heat of the lamp. I have perceived the characteristic odor of volatilized arsenic in lighting the gas with a wisp of arsenical letter paper. Such articles are constantly in the reach of children, and of adults ignorant as children of the dangerous character of the articles they are handling.

Who, knowing that a cake of emerald green—the favorite among all the colors—contains more than one-third of its weight of pure arsenic, would allow his children to use it unwarned? The use of green tarlatan in protecting chandeliers, picture-frames and mirror-frames, brings a dangerous article into the house. Not long since I saw, in a summer hotel, the dining table protected, in the interval between meals, by a voluminous net of green tarlatan, from which the arsenical powder was sifting upon the cloth and into the dishes at every touch. Has the time not come when this broadcast sowing of a dangerous and often unknown poison should be in some manner arrested?

Since I am considering arsenic in the arts as a cause of arsenical poisoning, I must not omit entirely the "Healing Art." You, gentlemen, use arsenic in a legitimate way. It has its place in the Materia Medica. Yet the toxicologist sometimes takes the liberty of overhauling the medicines dispensed according to the Doctor's prescription, just to be sure that all is right.

ARSENIC IN SUBNITRATE OF BISMUTH.

Not long since, I was called upon, in connection with a case in which a man was on trial for murder by poisoning, to give testimony as to what extent subnitrate of bismuth is contaminated with arsenic, it being well known that the ores of bismuth are rarely free from arsenic, and also that the complete elimination of it is exceeding difficult.

Indeed, one of the highest authorities, if not the highest, in toxicology, in a work not yet translated into English, says: "The ores of bismuth being always arseniferous, it follows that arsenic only too frequently accompanies bismuth in its compounds, and it is even claimed that the efficiency of the preparations of bismuth in cases of diseases of the stomach, should be attributed *to the arsenic* which such preparations nearly always contain."

In the case to which I allude samples of subnitrate of bismuth were obtained from all the druggists of the village, five in number, and brought to me for analysis. They all contained arsenic. I then obtained a number of samples from different druggists in this city. These likewise all contained arsenic, except a single specimen of Parisian manufacture, which was entirely free.

In closing his address, Professor Lattimore presented a specimen of the metallic arsenic obtained from subnitrate of bismuth recently analyzed. Also, a number of specimens of paper of various kinds, all colored with arsenical pigments—wall paper, letter paper, envelopes, fancy paper, card-board, tickets, etc., among the rest a "milk-ticket."

One of these sheets—a programme of the Rochester Free Academy for 1875—was accompanied by one-third of a grain of metallic arsenic extracted from a single programme.

He also presented specimens of green tarlatan, with the arsenic in the form of sulphide extracted from a piece six inches square. It was equivalent to a little more than *two grains* of white arsenic. A yard therefore contains a quarter of an ounce of white arsenic, and a lady's dress, if made in style, three ounces. In response to a request from the audience Dr. Lattimore explained several easy and rapid modes by which the presence of arsenic might be detected in arsenical paper.

PRESERVATION OF GRAIN, ETC., BY MEANS OF BAR-IRON OR METALLIC MERCURY.

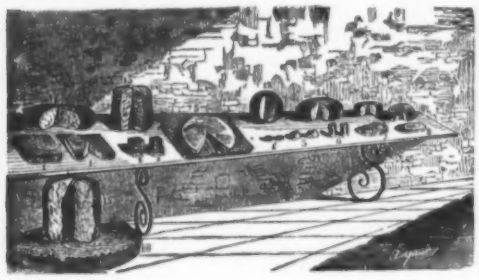
MR. MASSIE has made a number of experiments on a novel method of preserving certain organic substances, the results of which are given below in a condensed form.

He has been in the habit for several years of using an iron bar of about three lbs. weight as a means of preserving barley, rice, and bran in wooden boxes, well closed, and of a capacity of about forty gallons. In order to thoroughly test the efficacy of this method, he filled thirteen sets of litre-flasks with various substances, there being three flasks in each set, one of which (*a*) was filled with the substance without any addition, the second (*b*) containing the substance and a bar of iron weighing 80 gm. (1234.6 grs.), and the third (*c*) containing the same substance, together with 5 gm. (77.2 grs.) of mercury.

Barley, rice, bran, and various grades of corn, some of which was badly worm-eaten and partly alive with corn-moths before being placed into the flasks, were found to be entirely altered or destroyed in *a*; in *b* and *c*, however, they were perfectly preserved, and where alteration had already commenced before the addition of the protecting substances, the latter were found to have arrested the change. The same was found to be the case with ergot, in which case two different sets of flasks were used, one being left open and the other closed; the latter was found to have undergone less change in *a* (unmixed in closed flask); but in *b* and *c* both sets were equally well preserved. Whole Spanish flies were similarly treated, and also found completely protected from change. But the most remarkable case was an experiment with the Government biscuits ("hard tack"); the unprotected biscuits (in *a*) were entirely destroyed; the mass resembled a collection of small sieves; in *b* only a few perforations could be seen; and in *c*, which contained the mercury, the biscuits were completely preserved, without a trace of perforation by weevils. Each set was allowed to stand for the space of seven months.—*Rép. de Pharm.*, 1876, 195.

EUROPEAN CHEESES.

IT is probably owing to the greater attention paid in Europe to economy of food, that the varieties of cheeses there made so largely exceed those of American manufacture. Especially is this true of France, where the art of saving food is almost a science, as in that country four or five times as many kinds of cheese are produced as in England, Italy, and America combined. At a recent agricultural exposition in the Palais de l'Industrie, at Paris, a remarkably fine collection of cheeses was exhibited, and from some of these the annexed engraving taken from *La Nature* was prepared.



Those marked 1 and 2 are known as "maroilles," and are made either in block form or are wrapped in linen. No. 3 is "Fromage de Brie," made of the purest cream; this cheese, as well as "Neufchatel" (No. 6), are now largely made in New-Jersey, and can be obtained in New-York markets in a better condition than if imported. Nos. 4 and 5 are cheeses made of goat's milk. Nos. 7, 8, and 9 are known respectively as Mont d'Or, Camembert, and Lirarot cheeses. Roquefort cheese, No. 10, is made also of goat's or sheep's milk. After coagulation by rennet the curd is subjected to great pressure, and the cheeses are bandaged with coarse cloths and placed on shelves to dry, after which they are taken to cases where the bandages are removed; salting follows, and thereafter at intervals of 20 days the mould which forms on them is scraped off with a knife. In about two months the color changes from white to green, and then to red, the last color indicating that they are fit for use. Edam cheese, No. 11, is made in Holland, of milk alone; rennet is not employed, the coagulation being effected by hydrochloric acid. All Dutch cheeses have a sharp taste and high keeping qualities, but lack the mellowness of the French and Swiss productions. No. 12 is somewhat curiously called "Tête de Mort" (deadhead). No. 13 is Cheshire, a fine English milk cheese. Nos. 14 and 15 are respectively known as "Fromage de Gex" and "d'Auvergne." No. 16 is the famous "Gruyère" cheese, made in the Canton of Fribourg, Switzerland. This is said by the Swiss to have been the first cheese made by the factory system. It is made of whole milk, which, to the amount of 100 or more gallons, is heated while fresh in caldrons to blood heat, and rennet is added to effect coagulation in about half an hour. The curd is then sliced with a knife and broken with a blunt stick armed with wooden pins, and the heat raised to about 135°. Stirring is continued half an hour after, by which time the curd is divided into small elastic pieces of the size of peas. A strainer cloth is then drawn under the curds, and they are laid upon a rack to drain, after which they are placed in a peculiar hoop, formed of a thin piece of board bent into a circle, with the ends lapping, but left free to slide over each other to allow the cheese to spread in pressing. The press is a simple lever loaded with a weight at one end. The salting is done after the pressing, the cheese hoops being replaced after each application of salt for a few days to preserve the form. Jura cheese made in the Alps is much like Gruyère, and they are both known in this country as Schweitzer käse.

THE PERFECT HORSE.

HOW TO MEASURE HIM.

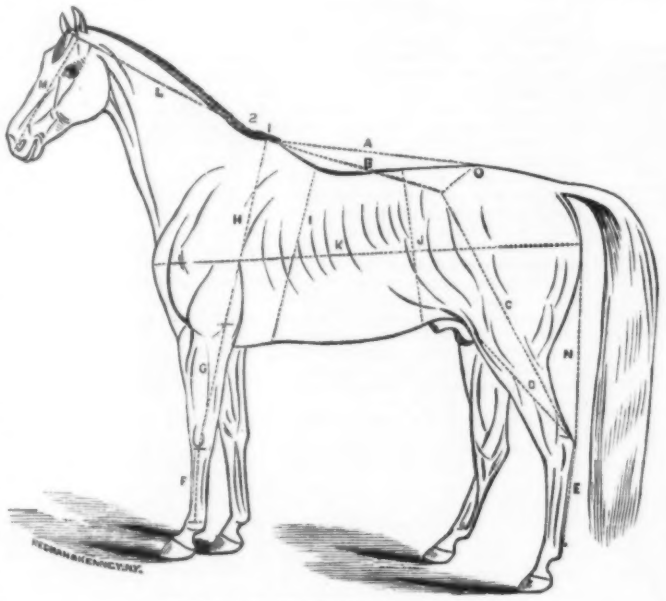
IN order to illustrate the mode of using our diagram and table, we have made a practical application thereof to "Kentucky Prince," a five-year-old bay stallion, owned by A. B. Darling, Esq., one of the proprietors of the Fifth Avenue Hotel, New-York. This stallion approaches very nearly to the *perfect horse*; and our table below gives all his principal measurements, and illustrates in a practical manner the proper method of measuring a horse. We are indebted to Mr. Darling personally for this valuable table, and also for the fine portrait of "Kentucky Prince," which accompanies, and, in this connection, the following history of said horse, taken from *Wallace's Monthly*, February 1, 1876, will be of special interest:

Kentucky Prince, bay stallion, with one white heel behind, foaled 1870; bred by John W. Thomas, Esq., of Bourbon County, Ky.; stands 15¾ hands; has an expressive countenance, significant of good temper; a longer neck than most trotting stallions; a capital shoulder, obliquely placed; withers high. His fore-legs are especially good, the fore-arm being long and well muscled, knee broad and strong, below which there is a goodly volume of bone, from which the back sinews are well detached, giving the limb a flat, clean appearance; pasterns of medium length, strong, springy, and set into hoofs that appear perfect in shape, size, and quality of horn. His back is strong, the loin being so braced on either side with fillets of muscle as to appear unusually broad even between wide hips that naturally tend to obscure the real power of this point. His ribs are well arched, and he is deep through the heart and the back ribs as well. He is long in the sweep from hip to hock, and deep from hip to whirlbone. His quarters are big with swelling muscle that reaches through the stifle and knots itself away down into the hock, giving him control from the loin to the latter point of a most extraordinary development of propelling power. This comes with more realizing force when he is seen in action. In this great and well-placed muscular development one readily accounts for the appreciable ease with which he recovers his hind-feet and drives them under him, sending himself forward with a regularly repeating stroke that leaves them again far back under the sulky. There is nothing labored, twitchy, or spasmodic in this action. It flows fully under control with the evenness of a metronome and the expressed power of an engine-crank. In front he goes smooth and reaching, with a well-rounded stroke. The slippery condition of the track did not admit of our seeing him "all out," but we "got the idea," and as he pulled up in front of us, with his veins distended with the glow of exercise, the taut muscles of his arm and stifle were as hard and rigid to the touch as a ship's cable. He was got by Clark Chief, one of the best sons of Mambrino Chief out of Kentucky Queen, by Morgan Eagle, an inbred Morgan horse, whose dam was a granddaughter of American Eclipse. The grandam of Kentucky Prince in the direct female line was a high-bred mare, possessing the blood of Blackburn's Whip, Brimmer, imp. Medley, etc. In his three-year-old form, after covering thirty mares, he was driven a mile in 2.36, after which he was purchased by Col. Richard West, of Edge Hill Farm, near Georgetown, Ky., a most sagacious horseman and an estimable gentleman—the same who brought into public notice such good ones as Molly Long, Blackwood, Lula, and Rosalind. On the day upon which Mr. Conley purchased him for Mr. Darling, he was driven a half mile over the Edge Hill track in 1.12¼—a remarkable performance for a three-year-old.

TABLE OF DIMENSIONS OF KENTUCKY PRINCE.

(See outline diagram accompanying.)

A,	Length of back from top of wither to line O, from hip to hip	34 in.
B,	Line from top of wither to hip	32 "
C,	" " hip to hock	39 "
D,	" " stifle to hock—length of limb	26 "
E,	" " hock to centre of ankle	18 "
F,	" " ankle to knee—centre to centre	12 "
G,	" " knee to elbow—length of forearm	18 "
H,	" " elbow-joint to top of wither	28 "
I,	Girth, forward	73 "
J,	" near the loin	73 "
K,	Length of body	68 "
L,	" neck, from poll to wither	38 "
M,	" head—extreme	24 "
N,	" from hock to extremity of buttocks	30 "
O,	Width from hip to hip—centre to centre	27 "



THE PERFECT HORSE.

1,	Height at withers	63 in.
2,	" O	63 "
3,	Ordinary fair weight	1200 lbs.
4,	Color, marks, mane, and tail (heavy, medium, or light).	

The Hub.

THE PEACH.

By Prof. S. T. MAYNARD.

FOR the past twenty-five or thirty years the peach crop in New-England has been almost a total failure. Several reasons may be given which will in part, perhaps, account for this result. When crops are abundant, and the market overstocked, the grower of course neglects to cultivate and care for his trees as he would if sales were easily made and at good prices. At the time when peaches were abundant in this section, they could hardly be sold at any price, and the trees, neglected, soon died from the attacks of the borer and yellows. This disease increased, borers multiplied, and if any young trees were planted, they soon shared the fate of the older ones. The trees had become weakened by heavy crops and the ravages of the borers, and made an easy prey to such a disease as the yellows.

Perhaps the greatest injury was done by the "peach-borer" (*Ægeria exitiosa*), the perfect insect of which is a small wasp-like moth, which flies in the night in summer, and lays its eggs upon the trunk near the ground. The eggs hatch, and the larvæ penetrate the bark, feeding upon the most vital part of the tree, the inner bark, and sapwood. The larvæ grow from one-half to one inch long, as many as six or seven being sometimes found in a single tree of medium size, while a single one will often completely girdle a small tree.

From the attacks of its many enemies, the wood failed to ripen thoroughly, and the immature buds were easily forced into growth by the warm days of winter, and if not destroyed in their unripened condition, would certainly be if cold weather followed the period which caused them to start. This process was going on for many years before the crop failed entirely, until there was scarcely trees enough to supply food for the borers, which from this cause, or some other, seem to have become less numerous. The "yellows," probably a fungoid growth, has become less destructive of late, without doubt, from the failure of proper conditions for its development, and within the past few years the peach has given promise of renewed vigor and fruitfulness.

The trees grow well, and, when properly cared for, give good crops of fruit; but the same causes which have produced failures in the past are still at work, though in a less degree.

The principal conditions of success in growing this most delicious fruit are four—namely, that young, healthy trees be carefully planted in a warm, light soil, made moderately rich, and upon high land exposed to a free circulation of the air at all times. That the fungoid disease known as the "yellows," which causes the leaves to assume a sickly yellow color, the fruit to ripen prematurely, and large numbers of small shoots to start from the main branches in clusters, be kept in check by destroying trees that may be affected by it. That the trees be examined in July and September for borers, which must be destroyed before they become large enough to do much injury. That the trees be kept in good condition by pruning or heading in every fall or spring when they are dormant. Trees that are not thus annually pruned soon take the form illustrated in Fig. 1; and when loaded with fruit

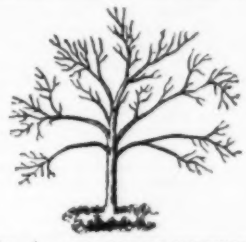


FIG. 1.—PEACH TREE UNPRUNED.

are sure to get more or less broken by the winds. Pruning in this way, the injury caused by overbearing is avoided. When all the fruit buds are allowed to remain upon the tree, its full force is directed to maturing the fruit, and the tree is liable to be injured, while the fruit is of an inferior quality.

If one quarter of the buds, or even one half, be removed, the effect of pruning when the tree is dormant being to increase growth, those buds that remain will produce much finer fruit, and the quantity will not be much diminished. A tree properly pruned is represented in Fig. 2.

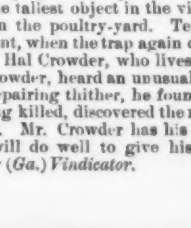


FIG. 2.—PEACH TREE PROPERLY PRUNED.

The success of the growers of this most delicious fruit in Delaware and New-Jersey is not due entirely to a congenial soil and climate, but to the careful and thorough manner in which they conduct their business. Orchards in these sections would soon become extinct if they were left to the ravages of the "borer" and the "yellows." They examine their trees once or twice each season for borers, and if any trees are attacked by the yellows, they are destroyed at once.

The best age for planting young trees is at one year from budding, but they require careful training for a year or two to give them proper shape.

They should be trained low, the main branches starting out at two feet from the ground. Trained in this way, with the shoots cut back every season, the fruit can be easily gathered, and the branches are not as liable to get broken.—*The Scientific Farmer.*

BLUE-EYED WHITE CATS NOT DEAF.

MANY persons are under the impression that white cats with blue eyes are deaf; it can by no means, however, be deemed to be so commonly the case as to be an evidence of much consequence in building a theory upon. A New-Zealand correspondent sends us some curious facts bearing on the point: "At Taranaki, N. Z.," he says, "I saw a white cat with blue eyes which was not at all deaf, and a good many of its kittens were white and had light-blue eyes. As many of these had perfect hearing as were afflicted with deafness. This cat had a grown-up kitten perfectly black, which had sometimes also white young ones with blue eyes; it showed, as did the old cat, a singular partiality for them. On one occasion it happened that the old white cat and her black daughter had litters at the same time; amongst them there was only one white kitten with blue eyes—the black cat's. The two fought fiercely for possession of the coveted beauty, and the old cat frequently took it away and placed it amongst her own. One morning the unfortunate object of quarrel was found divided by the recommendation of some feline Solomon, and each cat quite contentedly in possession of half. Both of these litters had some light tortoise-shell-colored kittens among them, of which a moiety appeared to have their hearing imperfect.—*Nature.*

THE ADVENTURES OF A STEEL-TRAP.

MR. MARK CROWDER, who resides a few miles south of Greenville, has a small steel-trap, which he placed in his chicken-house some months ago to catch the minks that were troubling his poultry. One or two minks being caught by it, the trap disappeared without any one on the place being able to explain the cause. A week or ten days after the trap was missed the dogs caught and killed a mink in the swamp near Mr. Crowder's dwelling that had the missing trap fastened to one of his legs. After the minks, the owls becoming troublesome, Mr. Crowder placed the trap upon the top of a tall pole, owls usually alighting upon the tallest object in the vicinity when meditating a descent upon the poultry-yard. Ten owls were caught by this arrangement, when the trap again disappeared. About a week afterward, Hal Crowder, who lives three miles from his father, Mark Crowder, heard an unusual commotion in his poultry-house. Repairing thither, he found an owl in the house, which, on being killed, discovered the missing trap fastened to one of its feet. Mr. Crowder has his trap again, and rogues of all sorts will do well to give his premises a wide berth.—*Merriwether (Ga.) Vindicator.*